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STATE OF CONNECTICUT.

EIGHTH ANNUAL REPORT

—OF THE—

STORRS

AGRICULTURAL EXPERIMENT STATION,

STORRS, CONN.

1895.

Printed by Order of the General Assembly.

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1896.

BOARD OF TRUSTEES

—OF THE—

STORRS AGRICULTURAL COLLEGE.

His Excellency, O. Vincent Coffin,

Wm. E. Simonds,	T. S. Gold,
H. C. Miles,	J. M. Hubbard,
Andrew Hyde,	E. S. Henry,
F. E. Blakeman,	S. W. Johnson.

OFFICERS OF THE STATION.

EXECUTIVE COMMITTEE.

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J. M. Hubbard, Middletown, } { *Storrs Agricultural College.*

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STATION STAFF.

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C. D. Woods, - - - - - - - *Vice-Director and Chemist.*
C. S. Phelps, - - - - - - - - - *Agriculturist.*
C. B. Lane, - - - - - - - - - *Assistant Agriculturist.*
O. F. Tower, - - - - - - - - - *Assistant Chemist.*

The Station is located at Mansfield (P. O. Storrs), as a department of the Storrs Agricultural College. The chemical and other more abstract work is carried out at Wesleyan University, Middletown, where the Director and Vice-Director may be addressed.

Report of the Executive Committee.

To His Excellency O. Vincent Coffin,
Governor of Connecticut:

In accordance with the resolution of the General Assembly concerning the congressional appropriations to Agricultural Experiment Stations, and an Act of the General Assembly relating to the publication of Reports of the State Agricultural Experiment Station, we have the honor to present herewith the Eighth Annual Report of that Station, namely, that for the year 1895.

The Committee refer to the accompanying report of the Treasurer for details of expenditure, and to that of the Director and his associates for the history of the work accomplished, and express their confident belief that the funds have been wisely expended and that the work is such as will result in great benefit to our agricultural interests.

Respectfully submitted,

T. S. GOLD,
J. M. HUBBARD,
B. F. KOONS,
} *Executive Committee.*

Report of the Treasurer

FOR THE FISCAL YEAR ENDING JUNE 30, 1895.

The following summary of receipts and expenditures is made out in accordance with the form recommended by the United States Department of Agriculture. The accounts have been duly audited by Auditors appointed by the Trustees of the Storrs Agricultural College.

TABULAR STATEMENT OF RECEIPTS AND EXPENDITURES.

RECEIPTS.

U. S. Treasury,	$7,500 00
Sale of produce,	43 99
Sale of apparatus,	88 37
Analyses,	69 00
Balance from 1893–94,	1 41
Total,	$7,702 77

EXPENDITURES.

Salaries,	$4,981 52
Labor,	179 52
Publications,	247 51
Postage and stationery,	269 53
Freight and express,	102 70
Heat, light and water,	315 69
Chemical supplies,	299 01
Seeds, plants and sundry supplies,	153 77
Fertilizers,	61 56
Feeding stuffs,	35 76
Library,	7 70
Tools, implements and machinery,	51 68
Furniture and fixtures,	293 66
Scientific apparatus,	385 18
Traveling expenses,	268 79
Contingent expenses,	20 00
Building and repairs,	27 50
Balance,	1 69
Total,	$7,702 77

HENRY C. MILES, *Treasurer.*

Report of the Director for the Year 1895.

BY W. O. ATWATER.

The principal subjects of inquiry and lines followed during the past year may be concisely stated as follows:

METEOROLOGICAL OBSERVATIONS.

These have been continued during the past year, as previously, at Storrs, where records have been made of temperature, barometric pressure, wind velocity, humidity, rainfall, and snowfall. In addition, records of rainfall during the growing season have been made in other places in the State by farmers who have conducted field experiments in co-operation with the Station.

FIELD EXPERIMENTS.

These have been: *(a)* With fertilizers; *(b)* With forage plants; *(c)* On green manuring.

As in previous years, the field experiments have been conducted at the Station and by farmers on their farms in different places. The results in the main are confirmatory of those of previous years, but with the increased experimenting the amount and value of the information gained increase in larger ratio.

IRRIGATION.

A new line of experimenting has been undertaken during the past season, in the form of tests of the effects of irrigation upon the production of strawberries. The work was done in co-operation with one of the prominent strawberry growers of the State, upon his own fields. The results were very successful and tend to confirm the impression that irrigation, not only of small fruits, but of other crops as well, may prove a much greater aid in their cultivation than has heretofore been supposed.

DAIRYING.

The work directly connected with the dairy interests has been mainly upon two subjects: *(a)* Bacteria of the dairy, including laboratory studies and co-operative experiments with creameries; *(b)* Yield and composition of milk on dairy farms.

Prof. Conn has continued the researches in his laboratory upon the bacteriology of milk, cream, and butter, which have been described from time to time in the publications of the Station, and has, during the past year, given especial attention to the bacteria of cream. Parallel with these more purely scientific studies, have been numerous experiments in creameries upon the action of bacteria in the ripening of cream and the making of butter. In these the action of the species which has come to be popularly known as "Bacillus No. 41" has been tested, and with very successful results. In numerous cases where trouble had been caused by undesirable flavors in the butter, the difficulty has been removed, and in a still larger number the quality of the butter has been improved by the use of the bacteria cultures. The cultures have been supplied to creameries, and arrangements are being made by which the Station may be able to distribute them more generally through the State.

It is becoming more and more certain that success in the handling of milk and the making of butter and cheese is largely a matter of the management of bacteria. These organisms are so minute that they can be distinguished only by the most powerful microscope; they occur abundantly in air, soil, water, and elsewhere; and they multiply so rapidly that millions are produced from a single one, and in a remarkably short time. They cause manifold changes in animal and vegetable substances, to which the terms fermentation, decay, and putrefaction are commonly applied. They are of many species and the different kinds have different effects. They get into the milk as soon as it is drawn from the cow, and multiply so rapidly that after a few hours a quart may contain as many as there are inhabitants in the United States. They cause the milk to sour, and sometimes make it "ropy," or impart offensive flavors to it. They are largely responsible for the flavor and other characters of the different kinds of cheese. They cause the ripening of cream, and decide the aroma and flavor of the butter. Some make it disagreeable to the taste, others give it the flavors that are most sought for and bring the highest market prices.

In discovering these and kindred facts, the students of bacteriology have made it clear that the successful handling of milk and the making of the best butter depend upon the right

management of bacteria. In other words, the dairyman needs to be a practical bacteriologist. He must control the bacteria and prevent their becoming too numerous and active in the milk he sells. He must keep the wrong ones out of the cream, and make sure that it contains the right ones, if he is going to make the butter which will have the best flavor and bring the best price. How he shall do this, the science of bacteriology is beginning to show him. Fortunately, if he is careful to keep his stable, his cows, his milk vessels, and his dairy clean, the bacteria which get into his cream will generally help him to make tolerably good butter. But he cannot always be sure that his butter will be the best, and sometimes it will be damaged despite the best care, unless he has some way of definitely controlling the bacteria. A great advantage of the species just referred to ("No. 41"), is that it not only produces a very desirable flavor, but also has the power of preventing, in some way, the action of species which cause bad flavors.

The subject is comparatively new to science, and still newer to practical dairying, but there is little room for doubt that researches like those now being carried on will bring great and constantly increasing benefit to the dairyman and to the public at large.

The tests of yield and composition of milk have been made in connection with the studies of rations fed to milch cows referred to in the next paragraph.

FOOD AND NUTRITION OF DOMESTIC ANIMALS.

The investigations have included: *(a)* Analyses of feeding stuffs, with determinations of their fuel values; *(b)* Studies of rations fed to milch cows on dairy farms; *(c)* Digestion experiments with sheep; *(d)* Feeding experiments with sheep.

In connection with the feeding experiments, a considerable number of analyses of feeding stuffs have been made. In each specimen, the fuel value has been determined by the use of the bomb calorimeter.

The studies of rations fed to milch cows on representative dairy farms in the State, which have been described in former Reports, have been prosecuted during the past year and with results no less gratifying than those in previous years. They add new emphasis to the doctrine which the Station has taught

from the beginning of its career, that the fodder which many, if not the most, of the farmers of Connecticut are in the habit of feeding to their cows is ill-balanced in its nutritive ingredients, and that more nitrogen in feeding stuffs is one of the essentials for the uplifting of our agriculture.

Another most important benefit which accrues from these experiments in the stable, like those with fertilizers and forage crops in the field, is in their educational influence. The man who makes a successful and instructive experiment in his field, barn, or dairy, not only learns something for himself, and does so in a better way than would otherwise be possible, but he also has something to communicate to his neighbors and to the public at large. Furthermore, such information has an especial value to other farmers; being the fruit of the actual experience of one of their fellow-workers, it has a meaning for them which it would not have if it came only from the Station. At the same time the Station experimenters reap a benefit from the direct work with the farmer, in that they learn better what are his wants and how to meet them. This co-operation between the Station and the practical farmer is a means of making direct practical application of the results of scientific research; it brings new information, and it is one of the most effective means for the dissemination of knowledge. Thus, in a three-fold way, it benefits the public which the Station is endeavoring to serve.

The digestion experiments with sheep are similar to those previously reported. Their object is to learn what proportions of the nutritive ingredients of different feeding stuffs are actually digestible. As the results of such experimenting in Europe and in this country accumulate it becomes more and more probable that the different ruminants, as cows, oxen, sheep, and goats, digest very nearly the same amounts of protein, carbohydrates, and other nutritive ingredients from the same kinds of feeding stuffs. Hence the experiments on the digestion of different materials by sheep may be taken as an approximate measure of the digestibility of the same materials by milch cows. The greater convenience of handling sheep in such experiments is the reason for using them instead of cows for testing the digestibility of some of the feeding stuffs of importance in the State. The experiments of the past year have been with green fodders and hays.

The Station has made a number of feeding experiments with sheep at Storrs. During the past year it has been so fortunate as to have the co-operation of Mr. Charles E. Lyman, of Middlefield, who fattens a large number of sheep each year for the market. Mr. Lyman has set aside a certain number of lambs in his barn for experimental purposes. The food materials were weighed and analyzed and the effects upon increase of weight were noted. The work thus far done is regarded only as a beginning, but the results are already of very decided interest and value. This is another instance of the usefulness of co-operation between the Station and the farmer in practical experimenting.

FOOD AND NUTRITION OF MAN.

The inquiries in this direction include: *(a)* Analyses of foods; *(b)* Digestion experiments with man; *(c)* Studies of dietaries; *(d)* Calorimetric experiments.

A considerable number of analyses of food materials have been made in connection with dietary studies.

Experiments upon the digestibility of different foods by man are much needed. A number have been made in European and other foreign laboratories. Until lately, however, almost none have been undertaken in the United States. Investigations of this sort have been begun by the Station in co-operation with the Department of Agriculture. The method is very similar to that followed in tests of the digestibility of feeding stuffs by domestic animals. It consists in weighing and analyzing both the food eaten and the undigested residue.

Studies of dietaries, which the Station has carried on in co-operation with the United States Department of Labor for some time past, have been continued. The kinds, amounts, chemical composition, and costs of the food materials actually used in a number of families and boarding-houses have been observed. During the past year the School of Sociology, lately established in Hartford, has shared in the inquiry, and in a most useful way. The accounts of these investigations in previous Reports have shown the bad economy, both pecuniary and hygienic, which is practiced in the purchase and use of foods by a large part of our population, including especially people in moderate circumstances and the poor. The extent of this bad economy; the fact that it is due largely to ignorance

and the need of investigation to learn the facts, and of efforts to diffuse knowledge of the principles of food economy, are still further emphasized by the work of the past year.

The Station has also co-operated with the United States Department of Agriculture in dietary studies during the year.

EXPERIMENTS WITH THE BOMB CALORIMETER AND DEVELOPMENT OF THE RESPIRATION CALORIMETER.

The bomb calorimeter, of which an account was given in the last Annual Report, has been used for determinations of fuel values of a large number of specimens of foods and feeding stuffs. Some of these were made for Stations and other institutions not provided with this apparatus.

The researches with the respiration calorimeter are of a very abstruse character and unite several lines of inquiry, each of which must be prosecuted with the greatest patience. The results thus far obtained, however, are most encouraging. The work is being done in co-operation with the United States Department of Agriculture. The primary purpose is purely scientific, namely, to study the application of the laws of the conservation of matter and energy in the living organism. Beyond this is the more practical object of learning more of the laws of nutrition and the ways the food is used in the body. To obtain this most useful knowledge abstract research of the highest order is necessary.

GOVERNMENT CO-OPERATION IN FOOD INVESTIGATIONS.

The Experiment Stations of the country have hitherto studied the plant and the animal and their food and nutrition, but have given little or no attention to the food and nutrition of man, notwithstanding the paramount importance of the subject and the fact that it represents the chief purpose of agricultural production. This neglect is not the fault of the Stations, because the Act of Congress providing for their establishment and their support did not definitely authorize such inquiries. Indeed, the work the Storrs Station has previously done in this direction, has been accomplished with aid from the United States Department of Labor and from private sources. In 1894 the legislation with reference to the Stations was so changed by Congress as to call upon them to study the

economy of the food of man. At the same time an appropriation of $10,000 was made for the fiscal year ending June 30, 1895, to especially promote inquiry into the food economy of the people of the United States. The responsibility for the investigation is vested in the Secretary of Agriculture, who has assigned the inquiry to the Office of Experiment Stations of that Department. This work is being carried out in co-operation with a considerable number of experiment stations and colleges and other organizations, including the Storrs Station, whose Director has been placed in charge of the enterprise.

STATE APPROPRIATION FOR INVESTIGATIONS OF FOOD ECONOMY.

The General Assembly at its last session provided an annual appropriation of $1,800 for the Storrs Station, to be used "for the purpose of investigating the economy of the food and nutrition of man, and for investigations of the bacteria of milk, butter, and cheese, and their effect in dairying."

With this very material help the Station is able to greatly increase the amount and value of its inquiries in these directions. At present all of the food investigations of the Station are being conducted in co-operation with the general government, by which a considerable share of the expense is paid. By such co-operation a much larger amount of research is being carried on by the Station than the State appropriation provides for, and, at the same time, the contribution by this State to the enterprise is made much more fully available to the country at large. There is a like co-operation in the publication of the results of the inquiry. In this way the practical results of the work of the Station are made available to the citizens of the State, through the Station Reports and Bulletins, while much of the more technical details which are of decided scientific importance, but of less special interest to farmers and the public at large, are published by the general government.

BACTERIA IN THE DAIRY.

[During the past eight years investigations on the Bacteria of Milk have been conducted in behalf of the Station by H. W. Conn, Professor of Biology in Wesleyan University. Some of the results have been given in the publications of the Station, as follows: *Bacteria in Milk, Cream, and Butter*, Bulletin 4, and Annual Report for 1889, pp. 52–67. *Ripening of Cream*, Annual Report for 1890, pp. 136–157. *A Micrococcus of Bitter Milk*, Report for 1891, pp. 158–162. *The Isolation of Rennet from Bacteria Cultures*, Report for 1892, pp. 106–126. *The Ripening of Cream by Artificial Cultures of Bacteria*, Bulletin 12 and Report for 1893, pp. 43–68. *Experiments in Ripening Cream with Bacillus No. 41*, Annual Report for 1894, pp. 57–68. *Some Observations of the Number of Bacteria in Dairy Products*, Annual Report for 1894, pp. 69–77. *Cream Ripening with Pure Cultures of Bacteria*, Annual Report for 1894, pp. 77–91. See also *The Fermentations of Milk*, Experiment Station Bulletin No. 9 of the Office of Experiment Stations of the U. S. Department of Agriculture.

As this may come into the hands of persons who have not read the above articles, and are not familiar with the subject, the following explanations are reprinted from publications of the Station:

BACTERIA IN MILK.

Bacteria or microbes, as they are often called, abound in air, water, and soil, in animal and vegetable substances, and in living plants and animals. They are extremely minute and multiply with wonderful rapidity wherever the circumstances are favorable. Cold hinders their development. When heated long enough at the temperature of boiling water they are killed, but their spores, which correspond to seeds, may endure even this temperature for some time, though higher heat kills them speedily.

Bacteria grow with the greatest readiness in milk and cream. Hence they collect in milk and cream exposed to the air, and multiply rapidly.

A large number of different species of bacteria are found in milk and cream. Different species have different effects. Many of them sour and curdle milk at some temperature. A few induce changes that render milk alkaline with or without the formation of a curd. When a curd is formed, it differs in character

with different species of bacteria. The souring of milk is more complex than has been supposed; and while without much doubt souring always depends upon the action of bacteria, any one of a number of species, or several combined, may be the cause.

The longer a specimen of milk has been exposed to the action of bacteria, other things being equal, the greater will be the number of bacteria present. Hence it follows that cream will usually contain a very large number. The presence of these organisms, so far from being injurious, is of a positive advantage to the butter-maker, since it is by their action that cream is "ripened."

Vessels in which milk and cream are to be kept are a great source of contamination by bacteria. The latter gather upon the sides and in the joints, and develop in the minute portions of milk, grease, or other matters from which it is difficult to free the walls of the vessels completely by washing.

Two important points in the handling of milk and cream are brought out by these considerations:

First—The importance of keeping milk, so far as possible, free from bacteria by the exercise of the greatest cleanliness.

Second—The importance of cooling milk immediately after it is drawn from the cow in order to prevent the souring as long as possible.

BACTERIA IN CREAM.

Besides the ordinary souring of milk, there are many other changes which are produced by bacteria, as the ripening of cream, the ripening of cheese, butter becoming rancid, and others less common.

The chief object of the ripening of cream is to produce the butter aroma and flavor which, though very evanescent, control the price of the butter. This aroma and flavor the butter-maker owes to the bacteria; for by their growth the materials in the cream are decomposed and the compounds formed which produce the flavors and odors of high quality butter.

Different species of bacteria vary much as to the flavors which they produce, some inducing good, some extra fine, and others a very poor quality of butter. A majority of our common dairy species produce good, but not the highest quality of butter. Up to the present time the butter-maker has had no means of controlling the species in his cream, but has had to use those furnished him by the farmer. The bacteriologist can isolate and obtain in pure cultures the species of bacteria which produce the best flavored butter. He can then furnish them to the creameries to use as starters in cream ripening.

Among the food products exhibited at the World's Fair in Chicago, was a can of so-called preserved milk from Uruguay, which on testing was found to have been inadequately sterilized so that it was somewhat decomposed. Mr. W. M. Esten, of Middletown, was at the Fair in charge of an exhibit of the bacteria of milk, prepared by Prof. Conn and shown as part of the Experiment Station exhibit of the U. S. Department of Agriculture. The milk was placed in Mr. Esten's hands for bacteriological examination. He isolated several species of

bacteria and took them to Middletown, where they were further investigated by Prof. Conn, who was then engaged in the study of a considerable number of species, found by him in specimens of milk obtained in and near Middletown. The tests of the Uruguay species were begun in the autumn of 1893. In December of that year it was found that one of the species, which had been designated for convenience during the process of the investigation as No. 41, produced such an effect in the ripening of cream that the butter from the cream was pronounced by experts as having the flavor of the best June butter. It is an interesting circumstance that this bacillus, which has proved of so great practical value, should have come from a specimen of milk from the other side of the world, and that the accident by which the milk had been improperly prepared for preservation should have resulted in so useful a discovery.

The investigations by Prof. Conn have been carried on at Wesleyan University in the biological laboratory of which he has charge. A part of the cost of apparatus and compensation of assistants has been borne by the Station. In return Prof. Conn has furnished the Station with full accounts of the investigations and their results. These have been published in its Reports and Bulletins. In this arrangement, by which the Station and the agricultural public have received promptly and in full detail the whole of the results of this valuable inquiry at nominal expense and with no compensation to the author of the investigations, all the rights of discovery and authorship are reserved to him.

The following is the ninth of a series of articles on bacteria in the dairy, in the Reports of the Station.

W. O. ATWATER.]

IX.—A YEAR'S EXPERIENCE WITH BACILLUS No. 41 IN GENERAL DAIRYING.

BY H. W. CONN.

The last two Annual Reports of this Station have contained accounts of the use in the ripening of cream for butter making, of a bacterium which has been called "Bacillus No. 41." This organism was originally obtained from a specimen of milk from Uruguay, South America, which was exhibited at the World's Fair in Chicago, and among a large number of species that were used in laboratory experiments upon cream ripening, this proved the most satisfactory. During a period of a year the organism was studied in the laboratory, and practical tests of its action in the ripening of cream and making of butter were made in the neighboring creamery in Cromwell with the intelligent and skillful co-operation of the superintendent, Mr. E. D. Hammond. These experiments have been described in detail in the publications of the Station above mentioned. The general conclusion was that the organism, Bacillus No. 41, was of practical value in cream ripening, for the purpose of producing flavor in butter. After the demonstration by strictly scientific methods that the organism does have the power of producing the desirable butter flavor, it appeared desirable to extend the experiments from the limits of the laboratory and a single creamery, in order to learn whether the butter-makers of the country, in general, could obtain the same advantages from the organism that had been obtained in the single creamery where the practical experiments had been performed. There appeared to be only one way of doing this. The butter-makers in the country would not, of course, lend their creameries for experimental purposes, unless they were convinced that it was to be of direct advantage to them, and the only way in which the experimenting could be extended was by announcing the results that had been obtained in the Cromwell creamery and assuming that similar results could be obtained elsewhere.

It was with considerable hesitation that I consented to allow the experiments in this way to go out of my own hands. Of course as soon as the organism is taken from under the direct observation of the bacteriologist and is put into the hands of the ordinary butter-maker who has no knowledge of bacteria, the experiments become more loose in their application and more unsatisfactory in their results, and, what is still worse, they are no longer within the control which should be placed upon all such trials. When the experiments were extended from one creamery to one hundred, and these hundred creameries were scattered all over the country, it was, of course, no longer possible for me to obtain direct results from them, and the data upon which further information was to be based could be obtained only from the evidence of others. There is both an advantage and a disadvantage in this method of practical experimenting. The disadvantage is its inexactness, for the accuracy of results obtained and described by persons not entirely familiar with the subject cannot always be relied upon. The advantage rests in the fact that the results are less liable to be influenced by individual prejudices. The verdict as to the result of the use of the bacteria culture, instead of coming from one or two individuals who might be influenced by personal bias, would be given by hundreds who had no special reasons for being interested in the results. Moreover, it was certain that the butter made by the culture would, with this broader experimentation, fall into the hands of a large number of butter experts, and the general judgment thus pronounced would in the end be more satisfactory. Furthermore, it was plain that if the organism Bacillus No. 41, or any other similar organism, was to be of use to the butter-makers of the country it was necessary that its method of use should be such as would be practicable to the ordinary butter-maker. If it should prove simply that the organism when used in scientific experiment could produce a proper butter flavor but that it could not be used properly by the common butter-maker, its practical value, of course, would be nothing. Experiments in this locality had demonstrated that the organism did produce an improvement in the butter when used under proper conditions. It remained to be demonstrated that it could be introduced to the butter-makers of the country at

large in such a way that they, too, could obtain an advantage from it. For these reasons, in spite of my hesitation, it was finally decided to introduce the culture to butter-makers as widely as possible for the purpose of further testing its powers.

THE USE OF PURE CULTURES OF BACTERIA IN DAIRYING.

It may be well here to state in a word to what extent the use of pure cultures of bacteria is new to dairying and to science. Pure cultures for cream ripening have been employed before to some extent. The method was first adopted in Denmark by Prof. Storch, and was followed later in Germany and to a less extent in other countries. Several different pure cultures (*i. e.*, cultures of different species of bacteria) have been distributed and used for this purpose. In Denmark their use has become very common. A year ago their use was hardly known in the United States, although, at least, one pure culture was on the market. Thus the use of pure cultures is not new, although the species which has come to be known as Bacillus No. 41 is new to dairying, and more than this, its use involves a new principle. All such cultures hitherto used have been lactic organisms, which change milk-sugar to lactic acid and their use rapidly sours the cream. They cannot, therefore, be used to much advantage in cream already filled with bacteria, and to get the best results it is necessary to pasteurize the cream. Bacillus No. 41 is not properly a lactic organism. While it does produce a very little acid it never curdles milk or cream, but on the contrary it checks rather than hastens souring. It produces flavor without much acid. It can, therefore, be used in ordinary cream without pasteurizing. The use of lactic organisms is, then, not new, but the use of a bacterium in ordinary cream to produce flavor alone, depending upon the species already present to give sufficient acid, is new. To this extent, therefore, the use of Bacillus No. 41 involves a new principle. This difference is one of no little importance, since it makes great difference in the adaptability of the organism to our present methods of dairying. That the future may see a wide extension of the practice of pasteurizing cream before ripening is very probable, and in my opinion desirable. But that time has not yet come, and in order that a pure culture may be introduced into the

creamery of to-day it must be of value in unpasteurized cream. No pure culture will acquire very wide use to-day that cannot be used to decided advantage in ordinary cream. For this reason, since Bacillus No. 41 is not a souring organism, it was thought that it might prove practical to-day where other pure cultures have not. The extension of its use had, therefore, more significance than simply trying one new species in the same line as the other pure cultures before used.

DIFFICULTIES IN USING PURE CULTURES.

At the outset it was anticipated that there would be several difficulties to meet and that some of them might prove so great as perhaps to be insurmountable. The difficulties which I chiefly anticipated were four:

(1) *General carelessness in the creamery.*—It is, of course, well known that dairying is often carried on in a very slovenly fashion, no sufficient caution being taken to insure cleanliness, either in the barns, on the milk wagons, in the creamery, or in the process of butter making itself. It is impossible to make good butter under such poor conditions, and I anticipated at the outset that in many cases the culture would fall into the hands of butter-makers who had no care for cleanliness and carried on their butter-making processes in a wholly unsatisfactory fashion. It was impossible for me to control this matter, and for this reason it was anticipated that such individuals would be almost sure to fail in their use of the culture. Moreover, experience soon showed that some of these butter-makers got the idea that as soon as they had the culture cleanliness was no longer necessary. They seemed to believe that if they only introduced the proper culture into their cream they could then disregard all of the previous demand for cleanliness and still obtain proper results. Of course a butter-maker of this sort would be sure to fail in his use of the culture.

(2) *Handling the culture.*—The second difficulty anticipated was in the handling of the culture. Butter-makers know little of bacteria and nothing of the proper methods of handling them. The butter-maker who understands that the ripening of his cream is a matter of the growth of organisms is rare, and none could be found a year ago who had any notion of the

proper method of artificially introducing bacteria into his cream. The butter-maker must at the outset be educated. For this reason it was necessary to prepare specific directions for the use of the culture. But it was found impossible to make the directions brief enough to be easily followed and yet complete enough to fill all the conditions. Every one knows that the method of handling cream must vary with the conditions of the weather, and that summer and winter cream, or separator and gravity cream, must be treated differently. Since the directions sent to butter-makers had to be made as simple as possible they could not meet every condition of butter making. The butter-makers, therefore, it was anticipated, might err in two directions, either by failing to follow the directions carefully enough to insure any results at all, or by following them so closely and blindly that, in certain conditions of weather, the cream ripening would be a failure. For instance, it was necessary to give a temperature at which the cream should be ripened with the culture, but this temperature necessarily varies with the weather just as the best temperature for cream ripening must be varied without the culture. In other words, the method of using a pure culture in cream ripening was new to the butter-maker, and before any proper results could be obtained by means of it, it was necessary that this method should be thoroughly learned by the user. This could not be done in a week, perhaps not in a month, and to know it fully requires, indeed, a longer time. During this period when the butter-maker is learning to use the culture it was anticipated that many would become discouraged, drop the use of the culture and become persuaded that it did them no good, but it was hoped that the number who would persevere until they learned the proper use of pure cultures would be large enough to warrant a satisfactory conclusion as to the merits of the culture for actual use.

This problem of insuring a proper handling of the culture can only be solved as butter-makers learn the new methods. A partial solution has been devised during the year in a change of the form in which the organism is furnished. At first Bacillus No. 41 was furnished in a small quantity and the butter-maker was directed to build it up by inoculating it in a small lot of sterilized milk, and later by putting this milk into

a larger amount of pasteurized cream. But practical difficulties rendered this method unsatisfactory, and it was found necessary to devise a method of furnishing the culture to the butter-maker in large quantities direct from the laboratory, thus saving him one step in the process. After some experiments a device was adopted by which the culture was furnished in the form of a moist pellet, something after the fashion of a compressed yeast cake. The manipulation of producing these cultures in large quantities is, however, proving extremely difficult. Bacteria are so abundant in the air and in all liquids that it has been found a matter of excessive difficulty to cultivate Bacillus No. 41 in such way as to keep it pure and uncontaminated by the hosts of mischievous germs that come from various sources. It has been found necessary to use definite temperatures and special media for growth of the Bacillus, and even after it has grown it is very difficult to determine whether it is pure or whether it has become contaminated. This latter circumstance has proved very troublesome, and it has taken six months to learn positively how to recognize contaminated cultures quickly. For this reason it has been impossible to furnish the culture to the extent that it would have been desirable. Moreover, even at present the methods adopted are not wholly satisfactory. The difficulty of contamination is so very great that it requires the most careful and constant study with the microscope to determine whether the cultures sent to the butter-makers are pure cultures of Bacillus No. 41 or are mixed with others. Furthermore, in the form in which the cultures are sent it was found that, during the hot weather, moulds would very commonly develop on the pellet, and the presence of the moulds has proved injurious to the action of the culture. The methods of producing these cultures in large quantities are being constantly improved, and at the present time nearly all of the difficulties have been mastered. It is felt that no further trouble is to be anticipated from the contamination of the cultures by the growth of moulds or other organisms therein. The methods, however, are not yet perfected and will not at the present time be described.

The use of this new form has proved a great aid in correcting errors in handling the culture. The greatest source of trouble has been in building up the culture from a small

amount to an amount sufficient to inoculate a vat of cream. With the organism furnished in quantity in a pellet one step in this process is performed in the laboratory, and the use of the culture thus becomes possible in many places where it would not have been before. But even yet the errors in handling the culture are met constantly and must be expected until a more general knowledge of bacteriological methods is found among butter-makers.

(3) *Lack of interest on the part of butter-makers.*—A third difficulty which was anticipated was a lack of interest on the part of the butter-maker. A large part of the butter-makers of the country are merely paid laborers and take comparatively little interest in the quality of their product. It makes no difference in their wages whether their butter is good or poor and they are not anxious to introduce into their butter-making any processes that give them extra labor.

This lack of interest has been very largely dissipated by the dairy journals of the country. The butter-making communities took hold of the matter of using this organism more readily than was anticipated, and during the last eight months the dairy press has attracted to the culture all of the public interest that was needed. Indeed, I have been inclined to think that the public attention that has been given to Bacillus No. 41 has been too great for its proper testing, but this is a matter that it was impossible to control. When dairymen thought that they had a means of controlling the flavor of their butter, they did not hesitate to say so, and the dairy journals have given a notoriety to the use of this organism which was not at all anticipated a year ago and was not, indeed, wished by myself. The rapidly growing interest in the use of the culture has resulted in an extension of the experimenting more rapidly than would have been desired for the experimental purposes. If it had been possible to confine the experiments to 25 or 30 creameries during the last year the results would have been far more satisfactory. This, however, was a practical impossibility, and when once the culture began to be known it was called for in many localities and has been used in very many places.

While the public press has in a large measure dissipated the lack of interest which was anticipated it has not done so

entirely. It is still found that the butter-makers themselves frequently take no interest in the subject and cannot be readily prevailed upon to use the culture. In some instances the butter-makers have actually thrown away the culture when it was furnished them by creamery superintendents rather than go to the trouble of using it, and in many cases they have only used the culture at the direction of the creamery superintendents, and then under more or less protest.

(4) *The bacteria already present in the cream.*—A fourth difficulty which was anticipated is one that may be simply mentioned as unknown conditions. The method of using this organism, as described in a previous paper,* is by making a large culture of it and then adding it directly to the cream in the cream-vat without any previous treatment of the cream. This method is in a measure new to science and to dairying. Other pure cultures have been used for the purpose of cream ripening in Europe and this country, but all of them have been acid organisms. In their use it is always recommended that the cream should be first pasteurized to destroy the bacteria already present. Without such pasteurization the lactic cultures hasten the souring and are unreliable, particularly in old cream. Bacillus No. 41 is an organism which checks rather than hastens the souring of the cream, and hence can be used to advantage in unpasteurized cream. In my own experiments we had found that the results of the use of the organism in unpasteurized cream were superior to those in pasteurized cream. The cream which is thus inoculated in any given creamery has been gathered from a large number of farms and is already filled with a considerable number of bacteria. These bacteria may be very numerous or they may be comparatively few, but there will always be a variety. Among them will be commonly some which will have an injurious effect upon the butter by producing unpleasant flavors during the ripening process. The value of Bacillus No. 41, under these circumstances, will depend, first, upon its being inoculated into the cream in great quantities so as to vastly outnumber all "wild" germs; and, second, upon its superior vigor, which enables it to grow at the expense of the

* *Experiments in Ripening Cream with Bacillus No. 41.* Report of this Station, 1894, pp. 57–68.

other organisms. In the experiments that were performed under my own observation, it was found that Bacillus No. 41, when inoculated according to the plan adopted, was able to overcome the injurious effect of all of the "wild" organisms that chanced to be in the cream. Further, since these experiments extended through all seasons and were uniformly successful it was proved that Bacillus No. 41 could overcome the different species of bacteria of different seasons. But from these experiments it was, of course, impossible to draw any universal inference, and it was recognized at the outset that there might be conditions under which the culture, as commonly introduced, would not be able to counteract the effects of the organisms already present. To prove a universal law requires a long series of experiments, and it was therefore anticipated at the outset that creameries might be found in which the introduction of the culture in the ordinary way would not produce the desirable effects, because of the presence in the cream before inoculation of too great a number of vigorous, malign species of bacteria. This difficulty, of course, was only a possible one, and nothing but a large number of tests could determine whether it was an actual obstacle. The experiments that preceded the general introduction of the organism to dairymen had demonstrated that if Bacillus No. 41 does get a chance to grow in the cream in abundance it will produce the proper flavor. They had demonstrated, moreover, that in all experiments up to that time the organism would grow rapidly in the cream if it was inoculated in proper quantities and would always produce its flavor. It remained, however, to be settled whether this would be found to be universally the case in practice, or whether there might not be instances where the method would not succeed. The testimony which the year's experience has given upon this question will be noticed later.

THE YEAR'S VERDICT.

The introduction of Bacillus No. 41 to dairymen began a year ago and there is thus about twelve months' experience to report upon. The results of these twelve months are of necessity given largely from the reports of those using the culture and selling the butter rather than from personal observation. It has been impossible for me either to oversee the

method of introduction or to examine the butter made in the creameries scattered all over the country from Maine to California. The only data from which I can draw my conclusions are the experience of the butter-makers and the commission merchants who handle the butter. The results of this experience I have in the form of many private letters, as well as a large number of communications that have been published in creamery and dairy journals, and also from the personal statements of commission merchants and butter-makers whom I have had the fortune to meet personally.

Judging from the large amount of testimony thus obtained, the results of the year's experiments have been satisfactory; indeed, far more so than I had any reason to expect. The difficulties which were seen, and have been outlined above, naturally prepared me to find that many butter-makers would use the culture without success, but, at the same time, to hope that among them would be a number that would have such positive success as to indicate that the method is a practical one when properly adopted. This expectation has undoubtedly been verified. In stating the results it is possible to give only a general summary, since the details are far too numerous and of a too miscellaneous character to be reported in full here.

The great majority of the testimony that has reached me as the result of the year's experiments has been of a highly satisfactory character. In some cases, indeed, an improvement is seen from the first, in others the first inoculation has produced no effect, but a second one has followed and has been successful. Nearly all who have persevered in their use of the organism have obtained satisfactory results.

In a large number of creameries the method of testing which has been carried on has been extremely rigid and as follows: A lot of cream has been divided into two parts, one part inoculated with the culture and the other left uninoculated. Both have been ripened under similar conditions, churned in the same way, and the resulting butter sent to commission merchants for sale. This method of experimenting gives an extremely severe test. It is open to objections, but it does serve to determine the commercial value of the "culture" butter. The verdict of a commission merchant upon the value

of the butter will, as is recognized by every one in the butter business, be more or less variable, and might not be the same upon two similar lots of butter at two different times. While individual results of this sort must, therefore, be open to some criticism, it is evident that the general verdict which will be reached by a series of such tests will be reasonably just, provided the method of use of the culture at the creamery is satisfactory. It must, however, be stated that the method that has been adopted in a great many cases is wholly inadequate and fails to make the test a sure one. In many cases most of the butter in the creamery has been made as usual, but a small lot, consisting of a tub or two, has been made with the culture. It is plain that such a test as this cannot be regarded as at all conclusive, since a small lot of this sort does not give the organism a fair showing.

The results of experiments of this sort have been in many cases to give a decided superiority to the "culture" butter. In some no difference has been seen by the commission merchant, and occasionally a lack of body in the "culture" butter (due to certain difficulties in churning) has caused the "culture" butter to grade a little the lower. In other cases butter has been rated at half a cent, a cent, two cents, and sometimes three cents a pound more than the butter made from the same cream without the culture. It is hardly probable that all of this extra price is due to the culture, but there can be no question that the culture has decidedly helped.

To cite the letters of commendation which have been written and published in regard to the use of the culture in this way is impossible. It is a fair summary of them, however, to state that in the great majority of cases creameries have been able to command a price varying from a half a cent to two cents a pound more for the "culture" butter than for the butter made at the same time without the culture; and while this is certainly not a universal verdict, it has been obtained in so many cases as to show the possibility that lies in this line of butter making.

One of the most severe tests was a recent one in which two lots of butter from the same cream, one with Bacillus No. 41 and one without, were submitted to 18 farmers to examine. A farmer's taste is commonly not especially discriminating for

fine grades of butter, and a difference appreciable to the ordinary farmer must be considerable. But, although these men knew nothing of the experiments, 17 out of the 18 declared the "culture" butter decidedly superior. An improvement which is seen by 17 out of 18 farmers certainly cannot be imaginary.

In a recent dairymen's convention in Iowa, among the 130 entries whose scoring was reported as over 90, 28 were those of "culture" butter. The "culture" butter obtained an average score of 94.5 points for separator butter, which was 1.4 points higher than the average of ordinary creamery separator butter. Gathered cream "culture" butter averaged 92.2, which was 1.2 higher than the average of gathered cream butter without the culture. In addition, "culture" butter took first prize for both separator and gathered cream butter, obtaining scores of 99 and 95 points respectively. It need not be pointed out that these are very high scores, and in view of them it cannot be questioned that Bacillus No. 41 has a decided value in practical butter making.

The effect of the culture upon the butter in the creameries, where it has been successful, appears to be in at least two directions. The first is an improved flavor, as has already been mentioned in early publications of this Station. The butter that has been obtained with the culture develops a pleasant "quick grass" flavor, which is appreciated at once by all lovers of first-class butter. The second effect is one that was not anticipated a year ago, and that is an increased keeping quality of the butter. It appeared to some from early experiments that the peculiar flavor imparted by this organism is evanescent—disappearing rapidly—but the tests of the year have certainly disproved this. There are no better judges of the keeping property than the commission merchants to whom falls the duty of keeping and selling the butter. It has been the verdict of commission merchants that the "culture" butter holds its own better than ordinary creamery butter. The peculiar, delicate flavor which appears at first does not disappear at once, and commission merchants in New York and Boston have stated that "culture" butter two weeks old still retains its fresh, quick flavor, and can be sold at the top of the market, whereas ordinary butter will in that time have lost a

little of its delicate flavor and must be sold a little under the top price. With some commission merchants in the last three or four months this has frequently made a difference of two or three cents a pound in the price obtained for butter. It has also been claimed by some, and among them no less authority than the official inspector of butter of the New York Chamber of Commerce, that "culture" butter, after being two months in cold storage, has been actually of a better flavor than when first put in. Only one other bit of evidence upon this subject has yet been brought to my attention. Quite recently some butter, which had been in cold storage for several months, was taken out for sale. Four men to whom it was submitted declared the "culture" butter better than the other butter which had been made from the same cream and placed beside it in cold storage; and one of them who had been somewhat skeptical as to the value of Bacillus No. 41, immediately determined to use it in his creameries as a result of this cold storage test. The data upon the matter is yet very meagre, however, and it is wise to reserve our verdict upon this matter of the long keeping quality of "culture" butter. That, for two or three weeks, the delicate flavor is retained by "culture" butter better than by ordinary creamery butter appears to have been demonstrated.

The question has frequently come up as to whether the use of the organism will enable a creamery to get rid of bad flavors as well as obtain a good one. Such bad flavors in butter frequently occur as the result of causes, sometimes known and sometimes unknown. For example, rag weed, garlic, and other plants are known to flavor the butter. I have been frequently asked if Bacillus No. 41 will remove such flavors. This question cannot as yet be answered positively, but the experience of the last year, so far as it has come under my personal observation, has been at least promising. In several cases butter-makers have written to me complaining of bad flavors and tastes in their cream and in the resulting butter, and asking if I could suggest the cause and a remedy. In all these cases I have furnished them with a culture of Bacillus No. 41, giving them directions for its use, and in every such instance, so far as I know, the result has been successful. The butter-makers have reported, in the course of a couple of

weeks, that with the use of the culture the bad flavor has disappeared, and there has appeared a new and pleasant flavor which was not in their creamery before. The most recent case of this sort that has come to my attention was in a creamery in Connecticut during October last. The butter-maker reported that within a week from the first use of the culture the bad taste had disappeared from his butter, and there had appeared in its place a pleasant flavor unlike anything that they had experienced before, and the butter was superior to anything they had been able to make at any time in the summer. While experiments in this line that have come under my personal attention have as yet not been very numerous, the few that have been made have been successful and give promise that in many cases at least bad flavors may be removed by the use of the culture. In many other instances, which have been indirectly reported to me, similar results have been obtained.

INSTANCES OF FAILURES.

Not all of the experiments have been thus successful. As was inevitable, the culture has been used in some places without reaping the desired advantage. Some of these instances have been brought to my attention, while doubtless others have not. For several months the plan was adopted of sending samples of Bacillus No. 41 very widely to all interested, without any adequate attempt to follow up the results. This proved unwise, since many of those to whom the sample was sent would try it more or less carelessly, and then, failing to obtain good results in the first instance, would drop it entirely and simply report failure or make no report. The butter-makers who have thus failed to find an advantage are disinclined to inform me, and I consequently have not the amount of information upon this matter that I desire. In nearly all cases that have come to my knowledge, these failures have been on the part of butter-makers who have obtained one sample only, and failing to get any results, have at once abandoned its use. Such a failure, of course, means absolutely nothing, for no butter-maker can expect to learn a new method of butter making in three days. In other cases it appears that failures have resulted even after several cultures have been faithfully tried. These failures cannot yet be fully explained. No such failures have occurred in creameries where I have

been able personally to superintend the introduction of the culture, and I anticipate it will be found that where they do occur they are due to some imperfection in the method of handling the culture in the cream ripening, or in its adaptation to special creameries.

Many facts in regard to the practical methods of using the culture are being constantly learned. The best temperature for ripening at different seasons, the best temperature for churning, the proper proportion of the culture to add to the cream, the best time to add it, etc.; all these are matters of practical importance and must be learned by practical experience before perfect success can be expected. Thus far in the year's experience it has appeared that, as the butter-makers do learn these facts and get more familiar with the method, the failures in many cases give place to success, and the lack of thorough adaptation of the method to the creamery is the cause of most of the lack of success. Undoubtedly, also, some of the failures in these "sample trials" have been due to moulds or other contaminations which occurred in the culture and ruined the value of the sample, and thus spoiled the experiment. Such troubles will not occur hereafter, because of improved methods of preparation of the cultures.

There is also a possibility that an occasional failure may be due to the fact that the creamery in question is infested with some vigorous organism which, under the conditions of experiment, does not allow the proper growth of Bacillus No. 41. If such is the case, the remedy is probably not difficult to find. One plan for meeting it may be in changing the methods of using the culture in such a way as to introduce into the cream a considerably larger amount of the Bacillus No. 41, and thus give it a better chance to grow at the expense of the mischievous organisms already present. A second plan which has worked well in some cases, is to make the first inoculation for the purpose of building up the culture in a specially selected lot of good cream.

It is, of course, impossible to give an explanation of all of these failures without the possibility of examining into the condition of the failures. It can be simply stated that, where I have been able personally to superintend the work, failures either have not occurred or have disappeared after change of

methods have been tried. It is further a fact that in many of the creameries where the first inoculation failed to produce the desired results, further experience with the culture and further inoculations soon produced the proper results, so that in many cases at least, the creameries that were at first unsuccessful with the culture, subsequently found their butter to improve.

Whether all these cases of failure can be attributed to the improper handling of the culture cannot, of course, be stated at present. The indications, however, so far as they can be drawn to-day, would seem to indicate that this is, at all events, the largest factor in explaining the failures; and if to this we add the occasional use of a mouldy or contaminated culture, the probability is that all cases of failure may be accounted for. At the same time it must be recognized that there may be creameries and conditions under which this culture will not produce its ordinary effect, and this can only be determined by a continuation of such experiments. The attempt is now being made to keep closer watch of the experiments in order to learn, so far as possible, the cause and remedies for the failures. New methods of use are being devised by the dairymen, and in a few months it will be possible to determine with more certainty how generally it will be possible to avoid failure and insure success by improved methods of handling.

IMPROVEMENT IN METHODS OF HANDLING "CULTURE" BUTTER.

The year's experimenting has given a great variety of tests and has taught many facts concerning the practical use of Bacillus No. 41. The method that has been finally adopted for the introduction of the organism into cream is simple. The butter-maker is directed to pasteurize (by heating at 155° F.) 6 quarts of cream, and after cooling to dissolve in this cream the pellet which is sent him containing Bacillus No. 41. This cream is then set in a warm place (70° F.) and the bacillus is allowed to grow for two days and is then inoculated into 25 gallons of ordinary cream. This is allowed to ripen as usual and is then used as a starter in the large cream-vats, in the proportion of 1 gallon of starter to 25 gallons of cream, and the whole is ripened at a temperature of about 68° for one day. The experience of butter-makers in the past year has taught many

secondary facts regarding the best methods of handling the organism in ripening cream. The most of these details concern practical dairying rather than bacteriology, but some of them may be properly mentioned here. It has appeared that cream ripened with this organism needs to be churned at a little lower temperature than ordinary cream to produce the best results as to body, grain, and flavor. A churning temperature as low as 52° to 54° is sometimes needed in order to produce the best butter and the highest flavor. Again, it has been found (first in laboratory experiments) that it is possible to keep cream sweet for a longer period by the use of the culture than without it. In my laboratory cream has been kept for nearly two weeks without becoming very sour, while cream that was not thus inoculated soured much more quickly. As one result of this fact, it has been found by butter-makers that cream does not sour so readily after it is inoculated with Bacillus No. 41, and that to a certain extent the souring already begun may be checked. The buttermilk that is made from cream ripened with the organism is, therefore, sweeter and keeps for a longer time than ordinary buttermilk. A very important practical matter has developed in the use of different lots of cream, namely, that cream from different patrons of the same creamery differs very much in character, and that when the first small lot of 6 quarts is taken as a starter it makes some difference whether this cream is taken from one source or from another. In some cases it has been found that the general run of cream, *i. e.*, the mixed cream in the creamery, is not properly fit to use for this purpose, and to obtain the best culture, and consequently the best results with Bacillus No. 41, it is necessary to use cream from some special patron for the first starter. This is easy to understand, inasmuch as the mixed cream in the creamery will be frequently impregnated with mischievous organisms which resist a temperature of 155°, and which come from some special patron of the creamery. The mixed cream will not, therefore, serve as well for a starter as cream from some special patron that is delivered from a source that is free from such mischievous organisms. It has been learned that, in using Bacillus No. 41 in pasteurized cream, it is necessary to use a higher ripening temperature than when ordinary cream is used, in order to produce the proper flavor

and acidity. In some cases, with pasteurized cream, a ripening temperature as high as 80° has been used with success. The fact that Bacillus No. 41 produces very little acid, renders this higher temperature desirable, both for causing a rapid growth of Bacillus No. 41, and also for developing a proper amount of acid from the other organisms that are left in the cream after the pasteurizing. With this higher temperature excellent results have been obtained in pasteurized cream, although the special advantage of Bacillus No. 41 is the possibility of obtaining first-class results in cream without pasteurizing.

As a practical method of use in cream-gathering creameries, it has been found very advantageous to place two or three quarts of the Bacillus No. 41 starter in the cream collector's cans before he starts on his rounds, in order that the organism may get a longer chance to grow in the cream. With this procedure the culture begins to do its work as soon as the cream is poured into the cans. In cases where the cream does not reach the creamery until somewhat late in the day, 12 or 1 o'clock, and must be churned early the next day, this introduction of the starter into the cans is extremely desirable, for otherwise not a sufficient time can be given to the cream for proper ripening.

A practical difficulty which some butter-makers have experienced is in overheating the original 6 quarts of cream. Such an overheating will give a scalded taste to the first churning, and occasionally the taste lasts for one or two churnings.

EFFECT IN SEPARATOR AND GATHERED CREAM SYSTEMS.

The result of the year's experiments indicates that the advantage of using Bacillus No. 41 is somewhat greater in creameries running on the gathered-cream system than in those creameries where the milk is brought to the creamery for separation by machinery. The reason for this appears to be as follows:

Where the milk is brought to the creamery and there separated it is ordinarily fresher, and the cream separated may then be held in the creamery under proper conditions. The whole of the ripening may thus be controlled in the creamery under proper conditions of cleanliness. Where, however, the

cream is separated from the milk at the individual farms, it is always kept at the farm for a longer period, and part of the ripening inevitably occurs before it reaches the creamery. The cream that is thus obtained is occasionally sour, and always varies widely in quality, and especially in the kinds and number of micro-organisms present. When such a miscellaneous lot of gathered cream is brought to the creamery, the butter-maker cannot depend upon the further ripening to give him such a uniformly good product as he can where the cream is separated fresh in his creamery. This is, in large measure, at least, the reason that separator butter as a rule is of a higher quality than gathered-cream butter. Now the use of Bacillus No. 41 has been found during the last year largely to obviate this irregularity in the gathered-cream system. The use of a large amount of Bacillus No. 41 in the gathered cream tends to obliterate the irregularities and imperfections which are common in the mixed lot of gathered cream, and the ripening is made more uniform and of a better character. Even the gathered cream is uniform in ripening, since it is all ripened by the same organism in excess. The result is, that the butter from the gathered cream more closely approaches butter made from separated cream, and, in some cases, butter experts have stated that they are unable to see any superiority of separated cream over gathered cream. This readily explains why the use of Bacillus No. 41 has been more noticeable in gathered-cream systems. It is, of course, plain that if this culture, or any other culture used in a similar way, can enable the butter-maker to obtain a product from gathered cream equal to that obtained from separated cream, it will be a very great boon to the butter-makers. At the present time, in many districts, a considerable portion of the cost of butter making, perhaps one-fifth, is in the carrying of the milk from the farm to the creamery, and if the method of using pure cultures could result in an equally good quality in both the gathered-cream and the separated-cream methods, it would enable the butter-maker to save a considerable portion of this large expense. Then the individual separator could be placed upon the farm, and the farmer could have his own skim milk without the necessity of carrying it several miles to be separated by a central machine at the creamery. At present,

certainly the evidence seems to make it at least probable that the gathered-cream butter may be brought so nearly to an equality with butter made from creameries that have a central separator, as to give strong hope that the culture may enable the creameries to avoid this considerable item of expense. It should be further stated, however, that in the last two months the Bacillus has been obtaining better results in separator butter. The score above mentioned (99 points, with average of 95.5,) was made in separator butter. Gathered cream "culture" butter at the same time scored an average of 92.2, with a maximum of 95.

A problem somewhat akin to the above, is whether the organism will be of use only in creameries which fail to get first-class cream, or whether it can also improve the highest grades of butter in the best creameries. It is easy to see that a pure culture of a flavor-producing germ may be of value to the ninety-nine creameries that have difficulty in getting first-class flavor, but of no special value to the one creamery that makes the high-quality butter at the start. I do not think that the data in my possession make possible an answer to this question as yet. Most of the creameries that have used the culture have been among the ordinary ones. It is a fact that several of the high-grade creameries have used the culture and have been satisfied of an improvement even in their butter. But the number of such instances is yet too small to make it possible to draw any definite conclusions. Undoubtedly the most striking effect will always be among the ordinary creameries, but whether the highest grade of butter can be improved by the flavor imparted by Bacillus No. 41 can be better determined after a longer series of experiments.

MISTAKEN IDEAS.

The use of the culture has, during the last year, been subject to many mistaken notions. All that was originally expected was, that the organism would produce a flavor when allowed to ripen the cream in the proper fashion. It has no effect upon the general properties of the butter; the grain of the butter, the body of the butter, the yield of the butter, are not in any way directly affected by Bacillus No. 41, so far as present information goes. There is nothing more certain than

that this culture does not in itself affect the body or the grain of the butter. These matters are dependent upon methods and temperature of ripening and methods of churning. It has happened in some cases that the attempt to use the culture has resulted in a different texture to the butter, but this is simply a matter of churning and proper ripening. In creameries which have had the longest experience these methods have been so well adapted to the local conditions that the butter made does not differ in its texture and grain from that of ordinary butter. A butter-maker cannot learn a new method at once, and the use of this culture must be learned; the ripening of butter with the culture must be just as much a matter of individual skill on the part of the butter-maker as by the old method. If the butter-maker uses his knowledge of what ripening should be, and uses the culture to assist him in the process, he will find, as the experience of the year has shown, that he can make "culture" butter of the same texture as that which he ordinarily makes, and of a flavor which, in many cases, at all events, is decidedly superior to that made without the culture.

A single experience of a recent date may perhaps be mentioned as illustrative and instructive. In the use of Bacillus No. 41, butter-makers have been told to ripen their cream at a temperature of about 68°. During the intensely hot weather which occurred about the middle of September last, which was the most severe weather of the summer for butter making, not a few of those who were using this organism failed to adapt the conditions of ripening to the temperature. Cream obtained during this heated season was much more abundantly supplied with ordinary bacteria than usual. The common "wild" species which get into the cream multiply very rapidly during hot weather, and, as a result, the cream or milk received at the creamery was already well on toward souring. In spite of this fact the butter-makers added the culture as usual and ripened the cream at the same temperature. As was to be expected, the cream, in the course of 24 hours, became very much over-ripened and was decidedly too sour, and the butter made from it was of a decidedly inferior character. This occurred in several places, and during that period of intensely hot weather, therefore, the culture did not appear to produce

satisfactory results. The remedy for such a difficulty is along the same line that the butter-maker would follow to remedy the trouble without the culture. The ripening should be at a lower temperature, but in order to produce the proper results with Bacillus No. 41, if the ripening is to occur at a lower temperature, it would be necessary to add to the cream a larger amount of the culture than usual. This instance is mentioned simply as an illustration of the sort of difficulties that are sure to arise in the adaptation of any entirely new method of butter making by the butter-makers in practical dairying. There are, of course, other difficulties that will arise in the future in every creamery, but in all cases the butter-maker must use his judgment as well when he has the culture to rely upon as when he does not. It must not be expected that the use of Bacillus No. 41 will either sweep the creamery floor, clean out the creamery vats, or make it unnecessary for the butter-maker to use his own judgment and intelligence in ripening his cream. Bacillus No. 41, when used in the creamery, will add a flavor to the butter, but it is just as necessary for the butter-maker, if he wishes to make a good product, to use every precaution to regulate temperatures, to insure cleanliness, and to control other conditions, as if he were ripening the cream without the culture. The culture will assist him, but it will not perform all the operations for him, or enable him to be a mere machine.

PRESENT USE OF BACILLUS NO. 41.

Something over 200 creameries have, during the past year of experimenting, used this Bacillus No. 41 with success. The success has, it is true, been varied; some reaping a considerable financial profit therefrom, while others have been less fortunate. These creameries are most of them still continuing the use of the culture—over 200 using it at the present time. They are distributed all over the dairy section of our country, among no less than thirteen States. Some of them have used the organism now for eight or nine months, others for six months, others for two or three months, while some have only used it for a few weeks, at the time of writing. It is the most conclusive evidence of the value of Bacillus No. 41, that those creameries which have used the culture the longest are the most confident of its value. Creameries which have used the

culture for six or eight months, until they have become thoroughly familiar with its action and with the proper method of its use, are the most certain that they are reaping a decided and a constant advantage from it. Those that have used it in a single experiment, or only a very short time, are the ones that are the most doubtful as to its advantage to them. Among this series of 200 creameries we have various types. Naturally, the class of creameries that are ambitious to make the best product, are the ones that experimented first with the culture, and among the 200 creameries we have some of the very finest ones in the country. One of them has obtained butter which has sold in markets for eighty cents or more a pound—a fancy price, and, of course, not due by any means to the use of Bacillus No. 41, but rather to the general methods used in the creamery. Other creameries of high character have used the culture, others also that are of a very decidedly inferior grade have used it, and some have used it that normally have made butter of a very poor quality. In a single creamery, for instance, during the month of June, the quality of the butter was decidedly poor. The culture was introduced and the superintendent was requested to send a sample of his ordinary butter and one of the "culture" butter to an expert for rating. He consented to send a sample of the "culture" butter, but decided not to send a sample of his ordinary butter, because it was so decidedly inferior to that made with the culture at that particular time.

SUMMARY.

The experiments of the year in the practical use of Bacillus No. 41 have been convincing as to certain facts, but, of course, they have not as yet shown exactly what position this culture and method of butter making will take in the dairy interests in the future. Looking at all the facts from the scientific standpoint, I think we may summarize the results as follows:

First.—Experience of two years in laboratory experiments has demonstrated that this organism can produce in butter a pleasant, desirable flavor, and that it will do so if it is inoculated into the cream for ripening under such conditions that it can grow there rapidly enough, and its action is not prevented by disturbing causes.

Second.—It has been proved that the use of this organism for the production of flavor in butter is feasible in ordinary creameries, and in the hands of ordinary butter-makers, provided they will use proper methods and proper discretion.

Third.—It is certain that in most creameries, at all events, if Bacillus No. 41 can be introduced into the cream in sufficient quantity, and allowed to grow there during the ripening, it will improve the flavor of the butter and will, in many cases, remove unpleasant flavors and replace them by a desired "quick grass" flavor.

Fourth.—The flavor thus produced is not evanescent, but is retained in the butter even for a longer period than the flavor which is obtained without such ripening. In other words, a somewhat enhanced keeping property is given to the butter by the use of the culture.

On the other hand, we must recognize that the practical tests thus far performed have not definitely proved that Bacillus No. 41 will always and universally produce the desired effect, and that there may be some creameries which will fail to obtain the proper results from the organism.

Fifth.—It has not yet been proved that Bacillus No. 41 is the best organism that can be used for this purpose, or that some other culture composed of a mixture of two or more different species of bacteria may not be found which will be, on the whole, more advantageous than Bacillus No. 41.

Lastly, we can safely say, I think, that the year's experience has demonstrated that the method adopted of using pure cultures in cream ripening is correct in principle, and will be successful in practice. The success in so many places in the first few months of its practical adoption in this country, is sufficient to indicate beyond question that the method of using the pure cultures, or some kind of bacterial starter, is the coming method in dairying for the purpose of producing high flavor and uniform quality in butter.

A STUDY OF RATIONS FED TO MILCH COWS IN CONNECTICUT.

see Bull 13.

BY CHAS. D. WOODS AND C. S. PHELPS.

The study of rations fed to milch cows on dairy farms in this State, which was begun in the winter of 1892–93, has been repeated each winter since, and it is planned to continue the work through the coming winter (1895–96).

Detailed descriptions of the work of the first two winters have been given in the Station publications.* The results of the third winter's work (1894–95) are here reported.

Each herd was selected after a personal inspection, or after sufficient correspondence to satisfy ourselves of its fitness for the proposed test, and a representative of the Station was present during the whole period of each test and personally attended to the details of the experiment, such as weighing the feeding stuffs, and taking samples for analyses, and weighing, sampling and determining the butter-fat in the milk. This work was faithfully performed by Mr. S. H. Buell, at that time the Station assistant in farm experiments.

In the first winter's work (1892–93), which was regarded as preliminary to an investigation that might extend over a series of years, it was thought better to examine a relatively large number of herds, each during a short period, than to make the periods longer and the number of herds less. Sixteen herds were visited and a five-days' test was made of each.

In the second winter's work (1893–94) six different herds were visited, and in four cases the time of study of the management and products of each herd was extended to twelve days. The analyses of the feeding stuffs were made at once, and the weights of nutrients in the rations as fed were calculated. In three instances other rations were thereupon suggested by us as being better than the ones that had been used. The owners gradually changed the food to the ration thus proposed, and, after an interval of four weeks from the close of

* Reports of this Station for 1893, pp. 69–115, and 1894, pp. 26–56. Bulletin 13 of this Station. Reports of the Connecticut Board of Agriculture, 1893, pp. 182–199; and 1894, pp. 131–146.

the first test, another twelve-days' test was made of the same herd. A comparison was thus made of the yields of milk and butter-fat with the two different rations.

During the third winter (1894–95) four herds were visited, each herd being under observation for twelve days at two different periods in the same manner as the three herds studied in 1893–94.

The chief points upon which information was obtained were:

Number of Animals in the herd.—In considering the number of animals, only those which came into the test were included. Usually these were all of the cows on the farm which were in milk at the time of the test.

Breed, age, and approximate weight of each cow.—The breed and age were obtained as accurately as possible from the owner. Since it was not practicable to take to the farm scales large enough on which to weigh the cows, the weights were estimated. This estimation was made in each case by the Station representative, and it is hoped that the errors of judgment may run more or less equally through all the herds examined.

Number of months since last calf.—In most cases the time at which the cow dropped her last calf was known.

Number of months till due to calve.—There was, of course, more or less uncertainty in this regard.

Weights of milk-flow for the twelve days.—The milk of each cow at each milking was weighed as soon as milked, to the nearest tenth of a pound, by the Station representative.

Percentages and amounts of butter-fat in the milk.—A sample of the milk of each cow, night and morning, was taken, and from the combined sample a determination of the quantity of butter-fat was made. The Babcock method of fat determination was employed. From the percentages of butter-fat in the milk, and the total weights of the milk, the daily yields of butter-fat were obtained.

Kinds and weights of foods used.—The feeder was requested to use the same kinds and amounts of feeding stuffs during the test period as he had previously used. The quantity for each animal was weighed by the Station representative just before feeding. Any portions of the food left uneaten by the cows

were carefully weighed, and due allowance was made for these uneaten residues in estimating the amounts daily eaten. During the test, usually on the third day, samples of each feeding stuff used were carefully taken and at once sent to the laboratory for analysis. From the results of the analyses and the weights fed, the total nutrients (protein, fat, nitrogen-free extract and fiber) fed each day were calculated. By the use of digestion coefficients, estimates were made of the weights of digestible nutrients in each day's ration.

The names and post-office addresses of the owners of the herds studied by the Station are given in the following list, together with the dates at which the Station representative was at the farm. At the left, in the first column of figures, is a reference number for each test. In the remaining tables, and in the discussion, the herds entering into the tests and the rations fed are designated by these reference numbers.

Names and Post-office Addresses of Owners of Herds Studied. Dates at which they were Visited, and Reference Numbers of Tests.

Number of Test.	Name and Post-Office Address of Owner.	Date of Test.
		1894.
27,	C. B. Davis, Yantic,	Dec. 10–Dec. 22.
28,	W. F. Maine, South Windham,	Dec. 24–Jan. 5, '95.
		1895.
29,	Same Herd as No, 27,	Jan. 7–Jan. 19.
30,	Same Herd as No. 28,	Jan. 21–Feb. 2.
31,	I. W. Trowbridge, Putnam,	Feb. 4–Feb. 16.
32,	R. L. Sadd, Wapping,	Feb. 18–Mar. 2.
33,	Same Herd as No. 31,	Mar. 4–Mar. 16.
34,	Same Herd as No. 32,	Mar. 18–Mar. 30.

EXPLANATIONS.

The following brief explanation of nutrients and their uses is reprinted from the Report of this Station for 1894:

Uses of food.—The two chief uses of food are to form the materials of the body and make up its wastes, and to yield energy in the form of heat to keep the body warm and in the form of muscular and other power for the work it has to do. The principal tissue-formers of the food are the protein or nitrogenous compounds. They build up and repair the nitrogenous materials, as the muscle and bone, and supply the albuminoids of blood, milk, and other fluids. The chief fuel ingredients of the food are the carbohydrates (such as sugar, starch, etc.,) and fat. These are either consumed in the body or stored as fat to be used as occasion demands.

Fuel value.—The value of food as fuel may be measured in terms of potential energy. The unit commonly used is the calorie. One calorie is the amount of heat necessary to raise the temperature of a pound of water about four degrees Fahrenheit.* From experiment it has been found that a pound of protein or carbohydrates yields, when burned, about 1,860 calories of fuel value, and that a pound of fat yields about 4,220 calories.

Nutritive ratio.—There is a very important relation between the amounts of protein (flesh formers) and the amounts of fuel constituents of a food. This relation is expressed by the nutritive ratio. The fuel value of fat is about two and one-fourth times that of the carbohydrates and the protein, hence it happens that if the sum of the digestible carbohydrates and two and one-fourth times the digestible fat of a ration is divided by the amount of digestible protein in the ration, the quotient gives what is called the nutritive ratio.

Wide ration.—Narrow ration.—If the quantities of digestible fat and carbohydrates are large relative to the protein, the nutritive ratio will be a large number and the ration is called a "wide ration;" if the quantities of digestible fat and carbohydrates are relatively small, the quotient is a small number and the ration is a "narrow" one. A ration where the nutritive ratio is much more than 1:6 may be called a "wide ration;" if much less, it may be called a "narrow ration."

Nearly all of the grasses and hays have a wide nutritive ratio, and the same is true of corn and many of its products, such as meal and hominy chops. The use of such feeding stuffs will tend to make a ration wide. The legumes, such as clover, peas, vetch, etc., and many of the products of milling and food manufacture are relatively rich in protein, and hence have narrow nutritive ratios.

The measure of the size of a ration.—In order that a ration may be complete, there must be enough digestible protein supplied in the food to build new tissues (bone, muscle, milk, etc.,) and repair the wastes of the body, and sufficient digestible fat and carbohydrates to furnish heat and muscular energy. As the chief function of the fat and carbohydrates is to serve as fuel, it is more important that enough of these should be provided to meet the needs of the animal than that they should be supplied in definite relative proportions. It is, therefore, possible to form a very good idea of the nutrients furnished in a ration, and to measure its size by the quantity of digestible protein or flesh-formers which it contains, and the fuel value of its digestible constituents.

RESULTS OF THE EXPERIMENTS.

Tables 1 to 8 inclusive contain in considerable detail the results of the observations and studies of the different herds.

The following abbreviations are used in the tables:

Abbreviations Used in Report of Rations Fed to Milch Cows.

Ay.=Ayrshire.	Gy.=Guernsey.	P.=Pure Breed.
Dev.=Devon.	Hol.=Holstein.	R.=Registered.
Dur.=Durham.	Jy.=Jersey.	Sw.=Swiss.
G.=Grade.	Nat.=Native.	

* The Calorie is exactly the heat necessary to raise the temperature of one kilogram of water one degree Centigrade. It is equivalent to 1.5 foot tons, or to the mechanical power that would lift 1.5 tons one foot.

The tables are alike in arrangement, and a description of one will serve for all. Each table contains the condensed results of a single test. Table 1, for instance, gives the statistics for test No. 27.

The first part of the upper table gives a reference number of each animal, its breed, age, weight, and number of months since last calf. The smallest daily milk flow, the greatest daily milk flow, and the average daily yield of milk for the period of the test are given in the next three columns. In the three following columns are given the lowest, highest and average percentages of fat found in the daily milk of each cow for the period. The figures were obtained by adding together the several daily determinations and taking the average, hence this actual average is not always half way between the highest and lowest. The yield of fat is given in the last three columns of the first or upper part of the table. The minimum and maximum yields of fats were obtained by multiplying each day's milk by its percentage of fat; the lowest number thus obtained gives the minimum daily yield of fat, and the largest the maximum yield of fat. It is to be noted that these numbers are not always the same as would have been obtained by multiplying the minimum and maximum daily milk flow by the minimum and maximum percentages of fat.

The lower part of each table gives the kinds and amounts of the different feeding stuffs eaten per day, and the weights of the digestible nutrients (protein, fat and carbohydrates) which they furnished. These weights are given per 1,000 pounds live weight and also per average weight of each herd. This last is the weights actually fed in each case, and they are given in the last five columns of the table.

As stated above, all of the different feeding stuffs used in these rations were analyzed. From the weights of the different feeding stuffs the results of the analyses and the digestion coefficients given in the following table, the weights of digestible nutrients were calculated in the usual way. The fuel value or potential energy furnished by the different foods was obtained by multiplying the number of pounds of protein and of carbohydrates by 1860, and the number of pounds of fat by 4220, and taking the sum of these three products as the number of calories of potential energy in the materials.

Coefficients of Digestibility used in Calculating the Digestible Nutrients in the Different Feeding Stuffs Used in these Rations.

Kind.	Protein.	Fat.	Carbohydrates.	
			Nitrogen-free Extract.	Fiber.
	%	%	%	%
Wheat bran,	78*	76*	72*	33†
Linseed meal,	86†	90†	80†	50†
Cotton seed meal,	89*	100*	68*	33†
Pea meal,	83*	54*	94*	26*
Corn meal,	76†	92*	87*	58†
Corn and cob meal,	76*	82*	84*	28*
Gluten meal,	87*	88*	91*	33†
Malt sprouts,	81†	68†	76†	64†
Good quality hay,	54*	54*	63*	55*
Poor quality hay,	45*	28*	60*	46*
Rowen hay,	62†	46†	67†	64†
Corn stalks (stover),	52*	52*	64*	66*
Corn silage,	46*	80*	67*	67*
Turnips, etc.,	84*	77*	95*	80*

* From results of American digestion experiments.

† From results of German digestion experiments.

In order to show the range of variation from day to day in the feeding of the same herd, the minimum and maximum daily rations per 1,000 pounds live weight and per average weight of each herd are appended to these tables. The size of the rations is here measured by the fuel value of the digestible nutrients (protein, fat, etc.). A ration which has a large fuel value may have a small amount of a given kind of food or a given kind of nutrients. Hence it sometimes happens that the minimum of one of the nutrients furnished by a certain kind of feeding stuff in a given ration may be greater than the average of the nutrients in that ration. The same may happen conversely, in the case of the maximum.

TABLE 1.

Dairy Test No. 27.—Statistics of Herd from December 10 to December 22, 1894.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow.			Daily Percentage of Fat.			Daily Yield of Fat.		
					Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	Jy., -	9	700	6	15.4	17.2	**16.1**	4.0	4.3	**4.1**	.62	.69	**.66**
2	Jy., -	5	750	6	18.1	20.1	**19.1**	3.8	4.0	**4.0**	.71	.80	**.76**
3	Jy., -	5	700	2	14.4	18.6	**17.3**	4.0	5.0	**4.3**	.70	.80	**.75**
4	Jy., -	9	600	4	17.2	19.3	**18.2**	4.2	4.8	**4.5**	.75	.89	**.82**
5	Jy., -	8	750	7	13.7	15.2	**14.4**	4.0	4.4	**4.2**	.58	.64	**.61**
6	P. Jy., -	3	500	6	8.2	10.0	**9.2**	4.9	6.0	**5.3**	.44	.54	**.49**
7	Jy., -	3	625	11	10.5	14.1	**11.6**	4.6	5.0	**4.8**	.50	.68	**.55**
8	P. Jy., -	4	500	3	16.0	18.6	**17.5**	4.6	5.6	**5.1**	.74	.99	**.89**
9	Jy., -	5	550	12	7.9	11.1	**9.5**	5.8	6.4	**6.1**	.51	.67	**.58**
10	Jy., -	2	500	8	9.5	10.8	**10.3**	4.7	5.2	**4.9**	.45	.55	**.51**
11	P. Jy., -	3	500	8	11.2	13.1	**12.1**	4.2	5.6	**4.9**	.47	.73	**.58**
12	P. Jy., -	3	500	7	11.4	13.1	**12.1**	4.2	5.0	**4.6**	.50	.65	**.55**
	Herd avg.	—	600	—	—	—	**14.0**	—	—	**4.6**	—	—	**.65**

Pounds of Food and Nutrients per Day per 1000 Pounds, Live Weight, and per Average Weight (600 Pounds) of Herd.

Kinds of Food.	Per 1000 Lbs., Live Weight.						Per Average Weight (600 Lbs.) of Herd.				
	Average Fed per Day.	Digestible Nutrients and Fuel Value.					Average Fed per Day.	Digestible Nutrients and Fuel Value.			
		Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.		Protein.	Fat.	Carbohydrates.	Fuel Value.
Average per Day.	Lbs.	Lbs.	Lbs	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs	Lbs.	Cal.
Corn meal, - -	7.6	.53	.29	4.84	—	—	4.6	.32	.17	2.90	—
Wheat middlings, -	7.6	1.12	.29	3.31	—	—	4.6	.67	.17	1.99	—
Total conc. food, -	15.2	1.65	.58	8.15	5.7	20700	9.2	.99	.34	4.89	12400
Stover, - - -	21.2	.50	.18	7.51	15.8	15650	12.7	.30	.11	4.51	9400
Total food, -	**36.4**	**2.15**	**.76**	**15.66**	**8.0**	**36350**	**21.9**	**1.29**	**.45**	**9.40**	**21800**
Minimum per Day.											
Concentrated food,	15.5	1.66	.59	8.37	5.8	21150	9.3	1.00	.35	5.02	12700
Coarse food, - -	16.1	.38	.14	5.71	15.8	11900	9.7	.23	.08	3.43	7150
Total food, -	31.6	2.04	.73	14.08	7.7	33050	19.0	1.23	.43	8.45	19850
Maximum per Day.											
Concentrated food,	15.0	1.62	.57	8.08	5.8	20450	9.0	.97	.34	4.85	12250
Coarse food, - -	24.7	.59	.21	8.76	15.6	18300	14.8	.35	.13	5.25	11000
Total food, -	39.7	2.21	.78	16.84	8.4	38750	23.8	1.32	.47	10.10	23250

TABLE 2.

Dairy Test No. 28.—Statistics of Herd from December 24, 1894, to January 5, 1895.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow.			Daily Percentage of Fat.			Daily Yield of Fat.		
					Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	Jy., -	—	700	3	18.3	19.9	19.2	5.0	5.2	5.1	.94	1.01	.98
2	P. Jy., -	—	850	3	12.6	13.9	13.0	5.2	5.6	5.4	.66	.78	.70
3	Nat., -	—	750	3	18.1	19.8	18.9	4.8	4.9	5.0	.90	.99	.94
4	Jy., -	—	800	2	10.6	14.4	12.3	4.8	6.0	5.3	.55	.86	.65
5	Jy., -	—	775	2	13.3	14.8	14.2	4.4	4.9	4.8	.60	.72	.68
6	Jy., -	—	850	1	16.3	24.1	22.1	4.2	5.2	4.6	.78	1.09	1.00
7	P. Jy., -	—	850	2	16.4	18.3	17.3	4.8	5.2	5.0	.79	.95	.86
8	Jy., -	10	750	3	14.3	16.0	15.3	5.2	5.6	5.4	.77	.88	.82
9	P. Jy., -	—	725	1	20.7	21.7	21.3	4.8	5.0	4.9	1.01	1.07	1.04
10	Jy., -	—	700	2	20.3	23.3	21.5	3.1	3.4	3.2	.65	.79	.69
11	Jy., -	7	750	—	24.6	27.8	26.3	3.4	4.4	3.8	.93	1.11	.99
12	Jy., -	—	725	—	20.7	24.0	23.2	4.0	4.6	4.3	.88	1.09	.99
13	Jy., -	8	750	8	12.3	13.7	12.9	5.4	5.8	5.6	.68	.77	.72
14	P. Jy., -	3	600	8	12.2	13.3	12.8	5.3	5.8	5.6	.68	.75	.72
	Herd avg.	—	750	—	—	—	17.9	—	—	4.6	—	—	.84

Pounds of Food and Nutrients per Day for 1000 Pounds, Live Weight, and per Average Weight (750 Pounds) of Herd.

Kinds of Food.	Per 1000 Lbs., Live Weight.						Per Average Weight (750 Lbs.) of Herd.				
	Average Fed per Day.	Digestible Nutrients and Fuel Value.					Average Fed per Day.	Digestible Nutrients and Fuel Value.			
		Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.		Protein.	Fat.	Carbohydrates.	Fuel Value.
	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs.	Lbs	Cal.
Grain, - -	14.5	1.41	.49	8.12	6.5	19750	10.9	1.06	.37	6.09	14800
Hay, - -	8.8	.30	.15	4.47	—	—	6.6	.22	.11	3.35	—
Stover, - -	7.1	.29	.09	3.49	—	—	5.3	.22	.07	2.62	—
Oat hay, - -	4.4	.18	.08	2.17	—	—	3.3	.13	.06	1.63	—
Total coarse food,	20.3	.77	.32	10.13	14.1	21100	15.2	.57	.24	7.60	15850
Total food, -	**34.8**	**2.18**	**.81**	**18.25**	**9.2**	**40850**	**26.1**	**1.63**	**.61**	**13.69**	**30650**
Minimum per day.											
Concentrated food,	14.2	1.38	.47	7.92	6.5	19300	10.7	1.04	.35	5.94	14500
Coarse food, -	19.4	.73	.31	9.39	13.8	20100	14.5	.54	.23	7.04	15050
Total food, -	33.6	2.11	.78	17.31	9.0	39400	25.2	1.58	.58	12.98	29550
Maximum per day.											
Concentrated food,	15.2	1.47	.51	8.48	6.6	20600	11.4	1.10	.38	6.36	15450
Coarse food, -	21.0	.79	.34	10.17	13.8	21800	15.8	.59	.25	7.63	16350
Total food, -	36.2	2.26	.85	18.65	9.1	42400	27.2	1.69	.63	13.99	31800

TABLE 3.

Dairy Test No. 29.—Statistics of Herd from January 7 to December 19, 1895.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow.			Daily Percentage of Fat.			Daily Yield of Fat.		
					Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	Jy.,	9	700	7	12.7	15.9	**14.8**	3.8	4.2	**4.1**	.48	.66	**.60**
2	Jy.,	5	750	7	17.5	19.4	**18.6**	3.8	4.2	**4.0**	.68	.79	**.74**
3	Jy.,	5	700	3	15.6	17.9	**16.7**	3.8	4.2	**4.0**	.59	.72	**.67**
4	Jy.,	9	600	5	16.5	18.7	**17.9**	4.2	4.8	**4.5**	.73	.88	**.81**
5	Jy.,	8	750	8	10.8	13.8	**12.0**	4.0	4.5	**4.2**	.45	.57	**.51**
6	P. Jy.,	3	500	7	9.2	11.1	**10.0**	4.4	5.4	**4.9**	.44	.56	**.50**
7	Jy.,	3	625	12	11.4	12.7	**12.0**	4.6	5.0	**4.8**	.53	.63	**.57**
8	P. Jy.,	4	500	4	16.4	19.2	**17.4**	4.6	5.3	**4.9**	.77	1.01	**.86**
9	Jy.,	5	550	13	7.3	8.3	**5.8**	6.1	6.8	**6.4**	.47	.53	**.51**
10	Jy.,	2	500	10	10.8	12.5	**11.6**	4.7	5.2	**4.9**	.53	.59	**.57**
11	P. Jy.,	3	500	9	10.9	13.7	**12.7**	4.0	5.1	**4.7**	.44	.64	**.60**
12	P. Jy.,	3	500	8	12.4	14.1	**13.1**	4.0	4.5	**4.3**	.53	.60	**.56**
	Herd avg.	—	600	—	—	—	**13.7**	—	—	**4.5**	—	—	**.63**

Pounds of Food and Nutrients per Day per 1000 Pounds, Live Weight, and per Average Weight (600 Pounds) of Herd.

Kinds of Food.	Per 1000 Lbs., Live Weight.						Per Average Weight (600 Lbs.) of Herd.				
	Average Fed per Day.	Digestible Nutrients and Fuel Value.					Average Fed per Day.	Digestible Nutrients and Fuel Value.			
		Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.		Protein.	Fat.	Carbohydrates.	Fuel Value.
Average per Day.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs.	Lbs.	Cal.
Grain,	20.7	2.97	.69	9.20	3.6	25550	12.4	1.78	.41	5.52	15350
Stover,	16.2	.51	.17	8.08	16.6	16700	9.7	.31	.11	4.85	10000
Total food,	**36.9**	**3.48**	**.86**	**17.28**	**5.5**	**42250**	**22.1**	**2.09**	**.52**	**10.37**	**25350**
Minimum per Day.											
Grain,	20.0	2.87	.66	8.88	3.6	24650	12.0	1.72	.40	5.33	14800
Stover,	13.5	.43	.15	6.75	16.5	13950	8.1	.26	.09	4.05	8350
Total,	33.5	3.30	.81	15.63	5.3	38600	20.1	1.98	.49	9.38	23150
Maximum per Day.											
Grain,	21.1	3.03	.70	9.37	3.6	26000	12.7	1.82	.42	5.62	15600
Stover,	17.1	.55	.19	8.54	16.3	17700	10.3	.33	.11	5.12	10600
Total,	38.2	3.58	.89	17.91	5.5	43700	23.0	2.15	.53	10.74	26200

TABLE 4.

Dairy Test No. 30.—Statistics of Herd from January 21 to February 2, 1895.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow.			Daily Percentage of Fat.			Daily Yield of Fat.		
					Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	Jy., -	—	700	4	19.1	23.3	**21.2**	4.2	5.4	**4.9**	.80	1.26	**1.04**
2	P. Jy., -	—	850	4	10.9	13.6	**12.3**	4.8	5.7	**5.3**	.57	.69	**.65**
3	Native, -	—	750	4	19.5	22.0	**20.6**	4.8	5.4	**5.1**	1.00	1.11	**1.05**
4	Jy., -	—	800	3	10.8	14.4	**13.5**	4.9	5.2	**5.0**	.56	.72	**.68**
5	Jy., -	—	775	3	13.6	16.2	**15.0**	4.4	4.8	**4.6**	.61	.74	**.69**
6	Jy., -	—	850	2	18.4	23.7	**21.3**	4.4	5.4	**4.8**	.85	1.15	**1.03**
7	P. Jy., -	—	850	3	15.5	18.7	**17.8**	4.6	5.2	**4.8**	.81	.89	**.86**
8	Jy., -	10	750	4	14.3	16.1	**15.3**	4.6	5.2	**4.9**	.70	.81	**.75**
9	P. Jy., -	—	725	2	17.9	21.8	**20.5**	4.7	5.6	**5.1**	1.00	1.13	**1.04**
10	Jy., -	—	700	3	21.2	24.7	**23.5**	3.2	3.5	**3.4**	.68	.84	**.80**
11	Jy., -	7	750	—	21.8	25.3	**23.4**	3.9	5.8	**4.8**	.94	1.32	**1.11**
12	Jy., -	—	725	—	20.8	26.5	**24.4**	2.8	5.2	**4.3**	.59	1.36	**1.07**
13	Jy., -	8	750	9	12.8	14.6	**13.7**	5.4	5.9	**5.6**	.70	.82	**.77**
14	P. Jy., -	3	600	9	13.4	16.0	**14.4**	5.0	5.6	**5.4**	.68	.88	**.77**
	Herd avg.	—	750	—	—	—	**18.3**	—	—	**4.8**	—	—	**.88**

Pounds of Food and Nutrients per Day per 1000 Pounds, Live Weight, and per Average Weight (750 Pounds) of Herd.

Kinds of Food.	Per 1000 Lbs., Live Weight.						Per Average Weight (750 Lbs.) of Herd.				
	Average Fed per Day.	Digestible Nutrients and Fuel Value.					Average Fed per Day.	Digestible Nutrients and Fuel Value.			
		Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.		Protein.	Fat.	Carbohydrates.	Fuel Value.
Average per Day.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs.	Lbs.	Cal.
Grain, - - -	11.9	1.67	.35	5.68	3.9	15150	8.9	1.25	.26	4.26	11350
Oat hay, - -	6.9	.30	.11	3.21	—	—	5.2	.23	.08	2.40	—
Stover, - - -	6.5	.26	.06	3.12	—	—	4.8	.20	.05	2.34	—
Hay, - - -	4.4	.18	.07	2.10	—	—	3.3	.13	.05	1.58	—
Total coarse food, -	17.8	.74	.24	8.43	12.1	18100	13.3	.56	.18	6.32	13600
Total food, -	**29.7**	**2.41**	**.59**	**14.11**	**6.4**	**33250**	**22.2**	**1.81**	**.44**	**10.58**	**24950**
Minimum per Day.											
Concentrated food,	11.9	1.67	.35	5.66	3.9	15100	8.9	1.25	.26	4.25	11350
Coarse food, - -	17.6	.74	.23	7.73	11.2	16700	13.2	.55	.18	5.80	12550
Total, - -	29.5	2.41	.58	13.39	6.1	31800	22.1	1.80	.44	10.05	23900
Maximum per Day.											
Concentrated food,	11.7	1.64	.35	5.57	3.9	14900	8.8	1.23	.26	4.17	11200
Coarse food, - -	18.6	.84	.25	8.68	11.0	18750	13.9	.63	.19	6.51	14050
Total, - -	30.3	2.48	.60	14.25	6.3	33650	22.7	1.86	.45	10.68	25250

TABLE 5.

Dairy Test No. 31.—Statistics of Herd from February 4 to February 16, 1895.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow.			Daily Percentage of Fat.			Daily Yield of Fat.		
					Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	Gr. Jy., -	3	900	5	11.9	13.9	**13.0**	3.8	4.6	**4.3**	.45	.64	**.57**
2	Gr. Jy., -	7	800	4	19.3	21.6	**20.4**	4.4	4.8	**4.6**	.88	1.04	**.95**
3	Gr. Jy., -	6	800	8	14.8	16.4	**15.4**	4.2	5.4	**4.9**	.63	.89	**.76**
4	Gr. Jy., -	5	750	8	10.4	12.6	**11.7**	5.2	6.6	**6.0**	.54	.83	**.70**
5	Gr. Jy., -	6	650	3	16.2	17.7	**17.2**	5.0	5.2	**5.1**	.84	.92	**.87**
6	Gr. Jy., -	10	850	3	16.0	20.6	**19.3**	4.2	5.0	**4.6**	.67	.99	**.89**
7	Gr. Jy., -	5	700	4	17.4	18.9	**18.2**	4.6	5.4	**4.9**	.83	1.00	**.90**
8	Gr. Ayr.,	7	750	8	14.1	15.8	**14.9**	4.2	4.8	**4.5**	.63	.72	**.67**
9	Gr. Jy., -	5	850	4	20.2	21.5	**20.8**	4.4	5.6	**5.1**	.90	1.14	**1.06**
10	Gr. Jy., -	12	850	2	25.5	28.3	**27.1**	3.4	4.0	**3.6**	.87	1.09	**.97**
	Herd avg.	—	800	—	—	—	**17.8**	—	—	**4.6**	—	—	**.83**

Pounds of Food and Nutrients per Day per 1000 Pounds, Live Weight, and per Average Weight (800 Lbs.) of Herd.

Kinds of Food.	Per 1000 Lbs., Live Weight.						Per Average Weight (800 Lbs.) of Herd.					
	Average Fed per Day.	Digestible Nutrients and Fuel Value.					Average Fed per Day.	Digestible Nutrients and Fuel Value.				
		Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.		Protein.	Fat.	Carbohydrates.	Fuel Value.	
Average per Day.	Lbs.	Lbs.	Lbs	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs	Lbs.	Cal.	
Grain, - - -	8.2	.90	.29	3.93	5.1	10250	6.7	.72	.23	3.14	8200	
Silage, - - -	43.6	.20	.34	4.32	—	—	34.9	.16	.27	3.46	—	
Coarse mixture, -	11.6	.55	.19	5.32	—	—	9.3	.44	.15	4.26	—	
Total coarse food, -	55.2	.75	.53	9.64	14.4	21550	44.2	.60	.42	7.72	17250	
Total food, -	**63.4**	**1.65**	**.82**	**13.57**	**9.3**	**31800**	**50.9**	**1.32**	**.65**	**10.86**	**25450**	
Minimum per Day.												
Concentrated food,	8.1	.89	.29	3.88	5.1	10100	6.5	.71	.23	3.10	8050	
Coarse food, - -	40.3	.68	.42	8.18	13.4	18250	32.2	.54	.34	6.55	14600	
Total, - -	48.4	1.57	.71	12.06	8.7	28350	38.7	1.25	.57	9.65	22650	
Maximum per Day.												
Concentrated food,	8.3	.92	.30	3.97	5.0	10350	6.6	.74	.24	3.18	8300	
Coarse food, - -	61.0	.78	.57	10.20	14.7	22800	48.8	.62	.46	8.16	18250	
Total, - -	69.3	1.70	.87	14.17	9.5	33150	55.4	1.36	.70	11.34	26550	

TABLE 6.

Dairy Test No. 32.—Statistics of Herd from February 18 to March 2, 1895.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow.			Daily Percentage of Fat.			Daily Yield of Fat.		
					Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	G. Jy., -	7	675	5	15.7	19.2	**17.5**	5.8	6.6	**6.0**	.96	1.13	**1.05**
2	G. Hol., -	2	650	2	22.0	25.1	**23.3**	3.6	4.1	**3.9**	.81	1.00	**.91**
3	R. Jy., -	4	650	2	20.8	25.8	**23.0**	2.7	3.8	**3.1**	.58	.89	**.72**
4	G. Jy., -		650	5	17.9	20.5	**19.1**	4.5	5.1	**4.8**	.87	1.00	**.92**
5	G. Hol., -	2	675	2	17.4	20.2	**18.7**	3.6	4.2	**3.8**	.65	.75	**.71**
6	G. Hol., -	4	850	7	17.2	19.6	**18.5**	4.4	4.8	**4.6**	.82	.90	**.84**
7	G. Hol., -	8	850	6	14.9	17.7	**16.5**	4.4	5.2	**4.8**	.74	.85	**.79**
8	R. Gr., -	8	800	1	26.2	32.7	**29.5**	4.4	5.5	**4.8**	1.15	1.63	**1.43**
9	G. Hol., -	8	1000	6	6.2	12.2	**9.6**	2.4	4.7	**3.4**	.19	.46	**.34**
10	R. Jy., -	6	800	1	24.7	30.1	**26.9**	4.0	4.9	**4.6**	1.14	1.60	**1.24**
11	G. Jy., -	7	850	10	7.2	9.7	**8.2**	5.2	5.9	**5.4**	.39	.52	**.45**
12	R. Gr., -	6	800	5	7.3	9.1	**8.2**	5.4	6.4	**5.9**	.45	.53	**.49**
13	G. Hol., -	6	900	6	12.5	17.8	**16.7**	4.4	5.4	**4.8**	.68	.85	**.80**
14	R. Jy., -	10	700	19	10.9	13.6	**12.2**	5.2	6.4	**5.9**	.64	.77	**.72**
	Herd avg.	—	775	—	—	—	**17.7**	—	—	**4.5**	—	—	**.81**

Pounds of Food and Nutrients per Day per 1000 Pounds, Live Weight, and per Average Weight (775 Pounds) of Herd.

Kinds of Food.	Per 1000 Lbs., Live Weight.						Per Average Weight (775 Lbs.) of Herd.				
	Average Fed per Day.	Digestible Nutrients and Fuel Value.					Average Fed per Day.	Digestible Nutrients and Fuel Value.			
		Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.		Protein.	Fat.	Carbohydrates.	Fuel Value.
Average per Day.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs.	Lbs.	Cal.
Buffalo gluten, -	6.7	1.59	.92	2.66	—	—	5.2	1.23	.71	2.06	—
Wheat bran, -	3.7	.59	.16	1.52	—	—	2.9	.46	.12	1.18	—
Total conc. food,	10.4	2.18	1.08	4.18	3.0	16400	8.1	1.69	.83	3.24	12700
Coarse mixture, -	8.4	.21	.13	3.95	—	—	6.5	.16	.10	3.06	—
Hay, - -	9.9	.37	.15	4.56	—	—	7.7	.29	.12	3.53	—
Total coarse food,	18.3	.58	.28	8.51	15.8	18100	14.2	.45	.22	6.59	14050
Total food, -	**28.7**	**2.76**	**1.36**	**12.69**	**5.7**	**34500**	**22.3**	**2.14**	**1.05**	**9.83**	**26750**
Minimum per Day											
Concentrated food	10.8	2.13	1.07	4.34	3.2	16550	8.4	1.66	.83	3.38	12850
Coarse food, -	16.4	.52	.25	7.62	15.7	16200	12.7	.40	.19	5.90	12550
Total food, -	27.2	2.65	1.32	11.96	5.7	32750	21.1	**2.06**	1.02	9.28	25400
Maxim'm per Day											
Concentrated food	10.7	2.23	1.08	4.28	2.9	16200	8.3	1.73	.84	3.32	12550
Coarse food, -	19.1	.60	.29	8.88	15.9	18900	14.8	.46	.22	6.88	14650
Total food, -	29.8	2.83	1.37	13.16	5.7	35100	23.1	2.19	1.06	10.20	27200

TABLE 7.

Dairy Test No. 33.—Statistics of Herd from March 4 to March 16, 1895.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow.			Daily Percentage of Fat.			Daily Yield of Fat.		
					Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	Gr. Jy., -	3	900	6	12.2	14.9	**13.6**	3.6	5.0	**4.4**	.44	.68	**.61**
2	Gr. Jy., -	7	800	5	21.4	22.9	**22.2**	4.2	4.6	**4.5**	.90	1.05	**1.00**
3	Gr. Jy., -	6	800	9	15.1	17.4	**16.1**	4.6	5.2	**4.9**	.69	.90	**.78**
4	Gr. Jy., -	5	750	9	8.0	10.6	**9.5**	5.4	7.8	**6.6**	.49	.83	**.63**
5	Gr. Jy., -	6	650	4	17.8	19.5	**18.6**	5.0	5.4	**5.2**	.89	1.03	**.97**
6	Gr. Jy., -	10	850	4	19.3	21.0	**20.5**	4.2	4.8	**4.6**	.83	1.01	**.94**
7	Gr. Jy., -	5	700	5	18.8	20.5	**19.7**	4.6	5.2	**4.8**	.87	1.01	**.95**
8	Gr. Ayr.,	7	750	9	13.2	15.4	**14.2**	4.4	5.2	**4.8**	.58	.74	**.68**
9	Gr. Jy., -	5	850	5	20.6	22.0	**21.6**	4.8	5.0	**4.9**	.99	1.12	**1.06**
10	Gr. Jy., -	12	850	3	26.7	31.5	**28.5**	3.1	3.9	**3.6**	.83	1.14	**1.01**
	Herd avg.	—	800	—	—	—	**18.5**	—	—	**4.6**	—	—	**.86**

Pounds of Food and Nutrients per Day per 1000 Pounds, Live Weight, and per Average Weight (800 Pounds) of Herd.

Kinds of Food.	Per 1000 Lbs., Live Weight.						Per Average Weight (800 Lbs.) of Herd.				
	Average Fed per Day.	Digestible Nutrients and Fuel Value.					Average Fed per Day.	Digestible Nutrients and Fuel Value.			
		Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.		Protein.	Fat.	Carbohydrates.	Fuel Value.
	Lbs.	Lbs.	Lbs	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs	Lbs.	Cal.
Average per Day.											
Grain, - - -	11.0	1.43	.55	4.99	4.4	14250	8.8	1.14	.44	3.99	11400
Coarse mixture, -	7.1	.29	.10	3.19	—	—	5.7	.23	.08	2.55	—
Coarse hay, - -	12.5	1.07	.29	4.95	—	—	10.0	.86	.23	3.96	—
Total coarse food, -	19.6	1.36	.39	8.14	6.6	19300	15.7	1.09	.31	6.51	15450
Total food, -	**30.6**	**2.79**	**.94**	**13.13**	**5.5**	**33550**	**24.5**	**2.23**	**.75**	**10.50**	**26850**
Minimum per Day.											
Concentrated food,	10.7	1.39	.53	4.85	4.3	13850	8.6	1.11	.42	3.88	11100
Coarse food, - -	19.6	1.36	.39	8.14	6.6	19300	15.7	1.09	.31	6.51	15450
Total, - -	30.3	2.75	.92	12.99	5.5	33150	24.3	2.20	.73	10.39	26550
Maximum per Day.											
Concentrated food,	11.1	1.44	.56	5.04	4.4	14400	8.9	1.15	.44	4.03	11500
Coarse food, - -	20.2	1.38	.40	8.41	6.8	19900	16.2	1.10	.32	6.73	15900
Total, - -	31.3	2.82	.96	13.45	5.5	34300	25.1	2.25	.76	10.76	27400

TABLE 8.

Dairy Test No. 34.—Statistics of Herd from March 18 to March 30, 1895.

Ref No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow.			Daily Percentage of Fat.			Daily Yield of Fat.		
					Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	G. Jy., -	7	675	6	14.2	17.3	**15.6**	6.0	6.8	**6.3**	.92	1.07	**.99**
2	G. Hol., -	2	650	3	19.9	24.0	**22.0**	3.8	4.2	**4.0**	.80	.93	**.87**
3	R. Jy., -	4	650	3	19.0	23.4	**21.4**	3.0	3.8	**3.3**	.61	.82	**.71**
4	G. Jy., -	9	650	6	14.5	17.6	**16.1**	4.6	5.3	**5.1**	.67	.90	**.82**
5	G. Hol., -	2	675	3	17.1	19.6	**18.4**	3.8	4.4	**4.1**	.68	.83	**.76**
6	G. Hol., -	4	850	8	11.4	17.3	**14.4**	4.8	5.2	**5.0**	.57	.81	**.72**
7	G. Hol., -	8	850	7	13.4	17.4	**15.0**	4.6	5.0	**4.9**	.62	.84	**.73**
8	R. Gr., -	8	800	2	23.8	27.7	**25.7**	4.4	5.6	**5.0**	1.17	1.44	**1.29**
9	G. Hol., -	8	1000	7	4.4	8.9	**6.2**	3.0	5.4	**3.9**	.14	.36	**.24**
10	R. Jy., -	6	800	2	20.8	24.5	**22.3**	4.5	5.3	**4.9**	.94	1.18	**1.09**
11	G. Jy., -	7	850	11	2.8	6.3	**4.6**	5.4	6.8	**6.0**	.17	.35	**.27**
12	R. Gr., -	6	800	6	5.6	6.8	**6.3**	6.0	6.4	**6.2**	.37	.41	**.39**
13	G. Hol., -	6	900	7	13.9	17.1	**15.7**	4.8	5.4	**5.0**	.73	.86	**.79**
14	R. Jy., -	10	700	20	10.0	12.0	**11.4**	5.6	6.8	**6.3**	.64	.77	**.72**
	Herd avg.	—	775	—	—	—	**15.4**	—	—	**4.8**	—	—	**.74**

Pounds of Food and Nutrients per Day per 1000 Pounds, Live Weight, and per Average Weight (775 Pounds) of Herd.

Kinds of Food.	Per 1000 Lbs., Live Weight.						Per Average Weight (775 Lbs.) of Herd.				
	Average Fed per Day.	Digestible Nutrients and Fuel Value.					Average Fed per Day.	Digestible Nutrients and Fuel Value.			
		Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.		Protein.	Fat.	Carbohydrates.	Fuel Value.
Average per Day.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs	Lbs.	Cal.
Grain, - -	10.2	2.05	.82	3.94	2.8	14600	7.9	1.59	.63	3.05	11300
Coarse mixture, -	11.3	.35	.16	4.88	—	—	8.7	.27	.12	3.78	—
Hungarian hay, -	6.8	.30	.10	3.03	—	—	5.3	.23	.08	2.35	—
Common mix'd hay,	2.3	.09	.03	1.04	—	—	1.8	.07	.02	.81	—
Total coarse food,	20.4	.74	.29	8.95	13.0	19250	15.8	.57	.22	6.94	14900
Total food, -	**30.6**	**2.79**	**1.11**	**12.89**	**5.5**	**33850**	**23.7**	**2.16**	**.85**	**9.99**	**26200**
Minimum per Day.											
Concentrated food,	8.2	2.00	.88	2.91	2.4	12850	6.4	1.55	.68	2.26	9950
Coarse food, -	18.6	.63	.27	8.30	14.1	17750	14.4	.49	.21	6.43	13750
Total, - -	26.8	2.63	1.15	11.21	5.2	30600	20.8	2.04	.89	8.69	23700
Maximum per Day.											
Concentrated food,	10.4	2.06	.81	4.07	2.8	14800	8.0	1.59	.63	3.15	11450
Coarse food, -	22.3	.81	.32	10.74	14.2	22850	17.3	.63	.24	8.32	17700
Total, - -	32.7	2.87	1.13	14.81	6.0	37650	25.3	2.22	.87	11.47	29150

TABLE 9.

Summary of Total and Digestible Nutrients Fed per Day per 1000 Pounds, Live Weight, on Dairy Farms in Connecticut.

Reference No.	Classes of Food.	Total Food.	Organic Matter.	Digestible Nutrients and Fuel Value.				
				Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.
1	Concentrated food,	8.3	7.2	1.58	.55	3.51	—	11790
	Coarse food,	43.6	18.3	.93	.44	9.73	—	21660
	Total food,	**51.9**	**25.5**	**2.51**	**.99**	**13.24**	**6.2**	**33450**
2	Concentrated food,	11.4	10.0	2.05	.49	5.58	—	16300
	Coarse food,	64.7	17.2	.74	.36	9.61	—	20700
	Total food,	**76.1**	**27.2**	**2.79**	**.85**	**15.19**	**6.1**	**37000**
3	Concentrated food,	10.7	9.4	2.39	.87	4.65	—	16770
	Coarse food,	27.9	17.5	.62	.28	10.13	—	21180
	Total food,	**38.6**	**26.9**	**3.01**	**1.15**	**14.78**	**5.7**	**37950**
4	Concentrated food,	10.6	9.2	1.47	.46	4.99	—	14000
	Coarse food,	30.5	22.0	1.15	.47	11.67	—	25800
	Total food,	**41.1**	**31.2**	**2.62**	**.93**	**16.66**	**7.0**	**39800**
5	Concentrated food,	8.2	7.2	2.20	.76	2.64	—	12200
	Coarse food,	46.3	22.4	.96	.49	12.55	—	27200
	Total food,	**54.5**	**29.6**	**3.16**	**1.25**	**15.19**	**5.7**	**39400**
6	Concentrated food,	7.5	6.5	1.23	.51	3.58	—	11100
	Coarse food,	26.6	20.1	.80	.36	10.97	—	23400
	Total food,	**34.1**	**26.6**	**2.03**	**.87**	**14.55**	**8.1**	**34500**
7	Concentrated food,	14.1	12.2	1.44	.65	7.70	—	19740
	Coarse food,	24.4	19.8	1.00	.44	10.30	—	22860
	Total food,	**38.5**	**32.0**	**2.44**	**1.09**	**18.00**	**8.4**	**42600**
8	Concentrated food,	12.2	10.4	1.60	.50	5.35	—	15050
	Coarse food,	28.7	23.3	1.56	.43	11.60	—	26300
	Total food,	**40.9**	**33.7**	**3.16**	**.93**	**16.95**	**6.0**	**41350**
9	Concentrated food,	7.4	6.3	1.20	.58	3.14	—	10500
	Coarse food,	22.2	16.5	.96	.25	8.91	—	19450
	Total food,	**29.6**	**22.8**	**2.16**	**.83**	**12.05**	**6.4**	**29950**

TABLE 9.—*(Continued.)*

Reference No.	Classes of Food.	Total Food.	Organic Matter.	Digestible Nutrients and Fuel Value.				
				Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.
10	Concentrated food,	8.2	7.0	1.09	.50	3.72	—	11100
	Coarse food,	22.3	17.4	1.23	.34	9.32	—	21000
	Total food,	**30.5**	**24.4**	**2.32**	**.84**	**13.04**	**6.4**	**32100**
11	Concentrated food,	10.2	8.9	1.91	.70	4.17	—	14250
	Coarse food,	22.6	17.5	.85	.31	9.29	—	20200
	Total food,	**32.8**	**26.4**	**2.76**	**1.01**	**13.46**	**5.7**	**34450**
12	Concentrated food,	13.1	11.1	2.29	.56	4.84	—	15650
	Coarse food,	48.5	12.3	.70	.38	6.57	—	15100
	Total food,	**61.6**	**23.4**	**2.99**	**.94**	**11.41**	**4.5**	**30750**
13	Concentrated food,	11.2	9.7	1.67	.64	5.27	—	15600
	Coarse food,	38.2	10.8	.53	.28	5.90	—	13150
	Total food,	**49.4**	**20.5**	**2.20**	**.92**	**11.17**	**6.0**	**28750**
14	Concentrated food,	9.4	8.4	1.71	.64	3.79	—	12900
	Coarse food,	22.3	17.8	.95	.41	9.30	—	20850
	Total food,	**31.7**	**26.2**	**2.66**	**1.05**	**13.09**	**5.8**	**33750**
15	Concentrated food,	8.8	7.5	.70	.37	4.79	—	11800
	Coarse food,	20.3	16.3	.65	.19	9.20	—	19100
	Total food,	**29.1**	**23.8**	**1.35**	**.56**	**13.99**	**11.3**	**30900**
16	Concentrated food,	6.9	6.0	.61	.46	3.74	—	10100
	Coarse food,	21.7	16.8	.83	.34	8.92	—	19500
	Total food,	**28.6**	**22.8**	**1.44**	**.80**	**12.66**	**9.3**	**29600**
18	Concentrated food,	12.3	10.6	1.80	.55	5.61	3.9	16100
	Coarse food,	32.2	20.0	.80	.45	10.84	15.0	23600
	Total food,	**44.5**	**30.6**	**2.60**	**1.00**	**16.45**	**7.3**	**39700**
19	Concentrated food,	10.7	9.2	2.00	.68	4.65	3.2	15200
	Coarse food,	18.9	15.3	.70	.25	8.48	13.0	18100
	Total food,	**29.6**	**24.5**	**2.70**	**.93**	**13.13**	**5.7**	**33300**
20	Concentrated food,	12.1	10.6	1.22	.39	6.42	6.1	15800
	Coarse food,	24.5	17.6	.75	.25	8.67	12.4	18600
	Total food,	**36.6**	**28.2**	**1.97**	**.64**	**15.09**	**8.5**	**34400**

TABLE 9.—*(Continued.)*

Reference No.	Classes of Food.	Total Food.	Organic Matter.	Digestible Nutrients and Fuel Value.				
				Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.
21	Concentrated food,	12.5	10.8	2.19	.59	5.15	3.0	16100
	Coarse food,	29.9	16.4	.71	.40	8.88	13.9	19500
	Total food,	**42.4**	**27.2**	**2.90**	**.99**	**14.03**	**5.7**	**35600**
22	Concentrated food,	10.0	8.6	1.06	.29	5.05	5.4	12600
	Coarse food,	16.4	14.3	.85	.27	7.46	9.6	16600
	Total food,	**26.4**	**22.9**	**1.91**	**.56**	**12.51**	**7.3**	**29200**
23	Concentrated food,	11.8	10.3	1.96	.42	5.38	3.3	15400
	Coarse food,	22.8	16.5	.72	.24	8.17	12.2	17550
	Total food,	**34.6**	**26.8**	**2.68**	**.66**	**13.55**	**5.7**	**32950**
24	Concentrated food,	13.6	11.5	1.97	.51	6.54	4.0	18000
	Coarse food,	20.4	16.8	1.51	.31	8.28	6.0	19500
	Total food,	**34.0**	**28.3**	**3.48**	**.82**	**14.82**	**4.8**	**37500**
25	Concentrated food,	10.8	9.3	1.60	.40	5.06	3.8	14100
	Coarse food,	16.8	14.7	.88	.31	7.48	9.4	16800
	Total food,	**27.6**	**24.0**	**2.48**	**.71**	**12.54**	**5.8**	**30900**
26	Concentrated food,	10.6	8.6	1.95	.83	4.16	3.2	14900
	Coarse food,	14.3	12.0	.57	.22	6.31	12.1	13700
	Total food,	**24.9**	**20.6**	**2.52**	**1.05**	**10.47**	**5.2**	**28600**
27	Concentrated food,	15.2	13.2	1.65	.58	8.15	5.7	20700
	Coarse food,	21.2	12.9	.50	.18	7.51	15.8	15650
	Total food,	**36.4**	**26.1**	**2.15**	**.76**	**15.66**	**8.0**	**36350**
28	Concentrated food,	14.5	12.9	1.41	.49	8.12	6.5	19750
	Coarse food,	20.3	17.8	.77	.32	10.13	14.1	21100
	Total food,	**34.8**	**30.7**	**2.18**	**.81**	**18.25**	**9.2**	**40850**
29	Concentrated food,	20.7	17.9	2.97	.69	9.20	3.6	25550
	Coarse food,	16.2	13.8	.51	.17	8.08	16.6	16700
	Total food,	**36.9**	**31.7**	**3.48**	**.86**	**17.28**	**5.5**	**42250**
30	Concentrated food,	11.9	10.1	1.67	.35	5.68	3.9	15150
	Coarse food,	17.8	14.9	.74	.24	8.43	12.1	18100
	Total food,	**29.7**	**25.0**	**2.41**	**.59**	**14.11**	**6.4**	**33250**

TABLE 9.—*(Continued.)*

Reference No.	Classes of Food.	Total Food.	Organic Matter.	Digestible Nutrients and Fuel Value.				
				Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.
31	Concentrated food, -	8.2	7.1	.90	.29	3.93	5.1	10250
	Coarse food, - -	55.2	16.9	.75	.53	9.64	14.4	21550
	Total food, - -	**63.4**	**24.0**	**1.65**	**.82**	**13.57**	**9.3**	**31800**
32	Concentrated food, -	10.4	9.3	2.18	1.08	4.18	3.0	16400
	Coarse food, - -	18.3	15.0	.58	.28	8.51	15.8	18100
	Total food, - -	**28.7**	**24.3**	**2.76**	**1.36**	**12.69**	**5.7**	**34500**
33	Concentrated food, -	11.0	9.5	1.43	.55	4.99	4.4	14250
	Coarse food, - -	19.6	16.3	1.36	.39	8.14	6.6	19300
	Total food, - -	**30.6**	**25.8**	**2.79**	**.94**	**13.13**	**5.5**	**33550**
34	Concentrated food, -	10.2	9.0	2.05	.82	3.94	2.8	14600
	Coarse food, - -	20.4	15.9	.74	.29	8.95	13.0	19250
	Total food, - -	**30.6**	**24.9**	**2.79**	**1.11**	**12.89**	**5.5**	**33850**
	Average of the above 34 Rations.							
	Concentrated food, -	10.7	9.3	1.62	.55	4.93	3.8	14500
	Coarse food, - -	26.4	16.3	.82	.32	8.76	11.6	19150
	Total food, - -	**37.1**	**25.6**	**2.44**	**.87**	**13.69**	**6.4**	**33650**
	*Average of 27 of the above Rations.**							
	Concentrated food, -	10.2	8.8	1.53	.55	4.75	3.9	14000
	Coarse food, - -	27.9	16.6	.82	.33	8.88	11.7	19450
	Total food, - -	**38.1**	**25.4**	**2.35**	**.88**	**13.63**	**6.7**	**33450**

* Seven of the above rations (Nos. 21, 23, 25, 29, 30, 33, and 34) were suggested by the writers. Hence the twenty-seven rations, the average of which is here given, actually represent the feeding practice of these dairymen.

Table 9, on pages 55 to 58, gives a summary of 34 rations used in feeding the dairy herds studied by the Station. Seven of these rations were, however, suggested by the writers, and therefore only 27 of them actually represent the feeding practice of these dairymen.

The total weights of food fed per 1,000 pounds live weight are given in the first column of figures. As explained above, all of the foods used in these experiments were carefully

analyzed and their chemical composition is therefore known. The weights of digestible nutrients were obtained by the use of factors (digestion coefficients), as explained on page 46. The last column but one contains the nutritive ratio, and the last column gives the calculated fuel value of the digestible nutrients in the rations.

As stated on page 44, it is possible to compare different rations by the quantities of digestible protein or flesh formers which they contain and the fuel value of their digestible nutrients. The extremes of these rations are pointed out in the following table, by comparing the maximum and minimum of organic matter, protein, fuel value, and nutritive ratio of all the rations in each case:

	Organic Matter.	Digestible Protein.	Fuel Value of Digestible Nutrients.	Nutritive Ratio.
	Lbs.	Lbs.	Calories.	1:
Minimum, - -	20.5	1.35	28,600	4.5
Maximum, - -	33.7	3.48	42,600	11.3
Average, - -	**25.4**	**2.35**	**33,450**	**6.7**

DISCUSSION OF THE RESULTS OF THE TESTS.

The discussion which follows is in great measure a repetition of what has already appeared in the Reports of this Station for the years 1893 and 1894. The reasons for this are two-fold: First, the subject of dairy feeding is such an important one that a constant repetition of the general principles involved seems necessary; and secondly, the results obtained in the tests here reported accord quite closely with those of past years.

The results brought out in such a study as the one here reported are tentative rather than final. This investigation was not undertaken with the expectation of obtaining startling facts, nor should we be warranted in drawing very definite conclusions from the tests. We do believe, however, that there is much of practical importance to be learned along this line of inquiry, and that the results herewith presented merit the careful attention of dairymen. The question of the relative economy of cattle foods is one that demands the careful consideration of our dairymen. The experiments point out

some valuable lessons as to the economy of foods when the effects on the products and the manure supply are both considered.

It is probably true that the animals of most of the herds examined were, so far as breed, milk and butter product are concerned, above the average of cows kept for dairy purposes in Connecticut. It is doubtless true that the feeding practiced by the owners of these herds is better than that which is generally practiced throughout the State. These facts, taken together with the shortness of the periods of observation to which the herds were subjected, have been kept in mind in the following discussion of the results of the tests, which is reprinted from Bulletin 13 of this Station.

A proper dairy ration will supply in appropriate forms the food constituents needed to form the materials of the body, and the energy required for heat and muscular work. In the case of the dairy cow the production of milk calls for a large proportion of food materials, and the energy required in its elaboration requires a considerable consumption of fuel. Just how much by weight of different food constituents should be fed is a matter of considerable uncertainty. Differences in breed and individual peculiarities of the animals, in the amount of milk produced, in the quality of the food, in the shelter afforded, as well as in other conditions known and unknown, all tend to show that the best rations for one cow may not be the best for another. The feeder must study his cows and fit the feed to their wants. He needs also to make a careful study of the market prices of feeds in order to use them most economically. While it is true that no fixed standard can be made applicable to the feeding of all dairy animals, yet an approximately close following of standards will prove better than the haphazard methods too often seen among feeders.

In the following table are given the commonly quoted standard ration proposed twenty-five years ago by Prof. Wolff, an eminent German chemist and experimenter; the average of 128 American rations as ascertained by the Wisconsin Experiment Station; the average of 16 rations fed in Connecticut in 1892 and 1893; of 25 rations fed from 1892 to 1894; and the average of 27 rations fed in Connecticut, 1892 to 1895; and a tentatively suggested ration.

German (Wolff's) Standard Ration, together with Averages of Some American Rations and a Tentatively Suggested Ration per 1000 Pounds, Live Weight.

Ration.	Organic Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Fat.	Carbohydrates.	Fuel Value.	
	Lbs.	Lbs.	Lbs.	Lbs.	Calories.	1:
Wolff's (German) Standard,	24.0	2.50	.40	12.50	29,600	5.4
Average of 128 American rations compiled by the Wisconsin Experiment Station,*	24.5	2.15	.74	13.27	31,250	6.9
Average of 16 rations as fed in Connecticut in 1892–93,	26.4	2.48	.94	14.09	34,800	6.5
Average of 24 rations as fed in Connecticut in 1892–94,	26.8	2.51	.90	13.92	34,350	6.3
Average of 27 rations as fed in Connecticut in 1892–95,	25.4	2.35	.88	13.63	33,450	6.7
Tentatively suggested ration,	25.0	2.50	(.5 to .8)†	(13 to 12†)	31,000†	5.6

* Wisconsin Experiment Station, Bulletin 38.

† In this suggested ration the fuel value could be supplied by about .5 of a pound of digestible fat and 13.0 pounds digestible carbohydrates; by .6 of a pound of digestible fat and 12.5 pounds of digestible carbohydrates; or by .8 of a pound of digestible fat and 12 pounds of digestible carbohydrates.

The German figures in the above table are based upon observations of the feeding practices of the best German feeders, and a large number of feeding experiments conducted by trained specialists, chiefly in experiment stations. The 128 rations compiled by the Wisconsin Experiment Station were obtained in response to letters sent by Prof. Woll to "dairy farmers and breeders of dairy stock in all parts of the United States and Canada, asking information concerning their methods of feeding milch cows." The author says, "It is hoped that the very varied conditions of feeding represented in the rations reported from the different regions of our large country will suit the cases of one and all American dairymen striving to improve their system of feeding so as to produce the largest quantity of dairy products at the least possible cost of foods." The results of the inquiries are summarized in the statement, "Combining all of the above 128 rations which have been fed by successful dairy farmers and breeders in various parts of

our continent, we have the following average American ration, as it may be called, as against the rations published by German experimenters heretofore largely used in this country."

This average, which is given in the table above, is designated as an "American Standard Ration for Dairy Cows," with the further statement that, "It is the result of American feeding experiments; the majority of our most successful dairymen feed in the way indicated by the dairy ration, and we shall not go far amiss if we follow their example." Average rations will vary in accordance with the number of individual rations used in obtaining the average. From the table just given it will be seen that the average ration fed in the herds studied in this State has been considerably changed during the past year. It would be absurd to consider any one of these averages as a standard ration. The average of these 128 rations represents the feeding practice of that number of American dairymen as calculated from the more or less accurate estimates of the feeders themselves, as to the amounts fed. The materials were neither weighed nor analyzed. The weights were the feeders' estimates and the composition was assumed from the average of other analyses. The variations in the amounts of the different food constituents in the different rations were very large. The ranges were:

Protein,	from 4.34 lbs.	to 1.03 lbs.
Carbohydrates,	" 19.29 lbs.	" 7.78 lbs.
Fat,	" 1.31 lbs.	" .31 lbs.
Nutritive Ratio,	" 1: 12.8	" 1: 4.0

If the estimates of weights and composition of the materials were correct, the amounts of the different nutrients fed by these 128 different dairymen varied all the way between these figures.

These estimates doubtless give a more or less fair indication of the ways in which good farmers commonly feed in the regions where the information was obtained. What would be the results of correct weighings and analyses of the fodders used by the same farmers, is uncertain. How closely such accurate data from these men would agree with equally accurate data regarding the practice of other feeders is likewise beyond our knowledge. The results of such inquiries are certainly very valuable, and it is to be hoped we shall have more, but until a much larger number are obtained, and with much greater

accuracy, no one will know what is the range or the average of nutrients in the rations actually fed by American dairymen. When such a range and such an average are found out, they will be chiefly useful in helping to show how dairymen in general need to change their rations in order to make their feeding more profitable. But taken by themselves, they will be far from fulfilling even this purpose. To make the best use of them, standard rations will be necessary for comparison.

As was pointed out in some detail in a previous article,* such a standard will have to be based upon the physiological demands of cows in general. To apply it to the best advantage in any given case, it will be necessary to take into account two further classes of data. The first will be the special characteristics of the cows of the given herd; the second will be the costs of the feeding stuffs and the values of the products. Of these three classes of facts which are of fundamental importance for economical feeding, namely, the general physical need of cows for milk production, the special peculiarities of individual cows, breeds and herds, and the costs of raw material and value of the products, such estimates give no exact information whatever.

In other words, even if the figures above cited are assumed to represent the actual feeding practice of the 128 dairymen from whom the reports came, there is nothing in them to show which individual feeders were feeding most, and which ones least economically. They throw no light upon the questions as to what is a proper physiological standard for the feeding of milch cows in general, or how the demands of the cows in any herd compare with such a general standard. They leave entirely out of account the prices and values which are so essential factors of the feeder's profit, and which may make a wider ration more profitable in one case and a narrower one in another, or very liberal feeding advantageous in one region or season when in another the profit would be increased by diminishing the ration.

Accurate observations of kinds, amounts and composition of feeding stuffs used in actual practice may give an average ration fed by a given number of American farmers, but to designate

* On Standards for Rations and Dietaries, by W. O. Atwater, Report of Storrs Experiment Station, 1894, p. 205.

it as the American Standard Ration for dairy cows, is a hardly justifiable use of the word standard, and to set it up as a model for farmers in general would be very misleading.

The Connecticut rations given in the table represent the actual practices of the dairymen whose herds were examined, so far as could be learned by weighing the foods fed day by day, and by determining their composition by chemical analysis. The factors used for calculating quantities of digestible nutrients are the chief sources of uncertainty here, but this is at present inevitable. In Germany there is a tendency to the more liberal use of protein, and the results obtained in experiments made in Massachusetts, as well as those here reported, indicate an increased milk and butter product and greater economy from rations containing quite large quantities of protein as compared with rations low in protein. The tentatively suggested ration of the writers was based upon the German standard of Wolff, as regards the amount of protein. As a result of some of our later experiments, and from close observation of the practices of many of our best feeders, we are inclined to believe that even larger quantities of protein than those here suggested would be better. We are now planning some further experiments for studying the question of the value of larger quantities of protein than that called for in our suggested ration. The ration proposed by the Wisconsin Station advocates less protein and more of fuel ingredients of the food than those contained in Wolff's standard. That the carbohydrates are more useful in the colder parts of this country than in milder climates is probably true, owing to their high fuel value. We must, however, remember that this class of foods will not prove a substitute for protein in milk production. Their relative cheapness has tended to increase their use in this country, but because we feed them liberally does not imply, much less prove, that we are using them wisely.

HERD TESTS DURING 1894–95.

In the winter of 1893–94 tests were made with four herds on wide and narrow rations, and the financial as well as the physiological results were observed. During the winter of 1894–95 four other herds were studied on the same plan. The

outcome of the second winter's work, and a summary of the results obtained during the two winters, is here given.

Samples of the different feeding stuffs used in the tests were taken early in each test and sent to the laboratory for analysis.

As soon as it was possible to obtain the results of the analyses, the ration fed was calculated, and suggestions were made for changes in the ration. After changes had been made and the animals had been upon the new ration for two weeks or longer, the herd was again visited and a new twelve-days' test was made.

Valuation of Feeding Stuffs as used in Rations fed Milch Cows in Winter of 1894–95.

Feeding Stuffs.	Market Price per Ton of Feeding Stuffs.	Estimated Value of the Manure Obtainable from One Ton of Feeding Stuffs.
Wheat bran,	$18.00	$12.00
Wheat middlings,	20 00	10.00
Imperial feed,	18.00	10.00
Cotton seed meal,	21.00	23.00
Buffalo gluten feed,	19.00	12 00
Chicago gluten meal,	21.00	15.00
O. P. linseed meal,	22.00	19 00
Corn meal,	19.00	7.00
Corn and cob meal,	16.00	5.00
Malt sprouts,	14.00	10.00
Corn ensilage,	2.50	1.75
Hay,	16.00	6.00
Oat hay,	12.00	6.00
Corn stover,	8.00	5.00
Corn fodder,	10.00	7.00
Bog hay,	8.00	4.50
Hungarian hay	12.00	6.00
Clover hay,	14.00	9.00

The prices of the feeding stuffs used in calculating the cost of rations were those current in September, 1895. They were obtained, in the case of the grain feeds, by sending circulars to grain dealers in five Connecticut cities asking the current prices of grains in ton lots, and averaging the figures thus obtained. The coarse fodders are based upon the market value of the various materials as estimated by farmers. The manurial value is based upon figures given in the Report of the Massachusetts Agricultural Experiment Station for 1893, pp. 358–365. The nitrogen in the feeding stuff is counted as worth

17½ cents, the phosphoric acid at 5 cents, and the potash at 5½ cents per pound for manure, and it is assumed that 85 per cent. of the quantities in the food may be saved in the manure. Unfortunately, most farmers take such poor care of the manure produced from the materials fed to their stock, that a much smaller percentage is usually saved.

DAIRY HERD D.—TESTS 27 AND 29.

Calculated per Head of 600 Pounds, Live Weight.

Feeding Stuffs.		Digestible Nutrients and Fuel Value.							
Kind.	Amount.	Protein.	Fat.	Carbo-hydrates.	Fuel Value.	Nutritive Ratio.	Cost.	Value of Obtainable Manure.	Net Cost.
First Test. December 10–22. 12 Days.	Lbs.	Lbs.	Lbs.	Lbs.	Calories	1:	Cts.	Cts.	Cts.
Grain, etc., Corn meal,	4.6	.99	.34	4.89	12400	5.7	9.0	3.9	5.1
Grain, etc., Wheat middl'gs,	4.6								
Stover,	12.7	.30	.11	4.51	9400	15.8	5.1	3.2	1.9
Total food,	**21.9**	**1.29**	**.45**	**9.40**	**21800**	**8.0**	**14.1**	**7.1**	**7.0**
Second Test. January 7–19. 12 Days.									
Grain, etc., Wheat middl'gs,	5.9	1.78	.41	5.52	15350	3.6	11.2	5.8	5.4
Grain, etc., Malt sprouts,	3.5								
Grain, etc., Corn meal,	3.0								
Stover,	9.7	.31	.11	4.85	10000	16.6	3.9	2.4	1.5
Total food,	**22.1**	**2.09**	**.52**	**10.37**	**25350**	**5.5**	**15.1**	**8.2**	**6.9**

The dairy herd represented in this test was studied by the Station representative December 10–22, 1894, and after an interval of two weeks was again studied January 7–19. There were twelve cows in each test—the same animals in both cases. Four of the animals were thoroughbred Jerseys, and the balance grade Jerseys. The average estimated weight was 600 pounds, and the average age five years. At date of the first test the average time since last calf was five months, and none of the animals were within four months of calving. The statistics of the rations fed are summarized in the above table. The second ration fed was considerably larger, and hence more expensive, than was intended. Malt sprouts formed quite a part of the second ration, and several of the animals did not seem to like this feed. Although four weeks elapsed between

the beginning of the first and the second tests, the animals kept up their milk flow and butter product at practically the same point on the second ration as on the first. A mistake was no doubt made in feeding so largely of a new feed, to which the animals had not been accustomed. The coarse fodder used in both cases was a very cheap one, and no improvement in the cost of the ration could be made by changing this.

DAIRY HERD E.—TESTS 28 AND 30.

Calculated per Head of 750 Pounds, Live Weight.

Feeding Stuffs.		Digestible Nutrients and Fuel Value.					Cost.	Value of Obtainable Manure.	Net Cost.
Kind.	Amount.	Protein.	Fat.	Carbohydrates.	Fuel Value.	Nutritive Ratio.			
First Test. Dec. 24, 1894, to Jan. 5, 1895. 12 Days.	Lbs.	Lbs.	Lbs.	Lbs.	Calories	1:	Cts.	Cts.	Cts.
Grain, etc., Imp. wheat feed,	3.6	1.06	.37	6.09	14800	6.5	9.0	3.6	5.4
Grain, etc., Corn & cob meal,	7.3								
Hays, etc., Hay,	6.6	.57	.24	7.60	15850	14.1	9.4	4.3	5.1
Hays, etc., Oat hay,	3.3								
Hays, etc., Corn stover,	5.3								
Total food,	**26.1**	**1.63**	**.61**	**13.69**	**30650**	**9.2**	**18.4**	**7.9**	**10.5**
Second Test. Jan. 21 to Feb. 2, 1895. 12 Days.									
Grain, etc., Imp. wheat feed,	3.0	1.25	.26	4.26	11350	3.9	8.3	5.0	3.3
Grain, etc., O.P. linseed meal,	3.0								
Grain, etc., Corn & cob meal,	2.9								
Hays, etc., Hay,	3.3	.56	.18	6.32	13600	12.1	7.6	3.8	3.8
Hays, etc., Oat hay,	5.2								
Hays, etc., Corn stover,	4.8								
Total food,	**22.2**	**1.81**	**.44**	**10.58**	**24950**	**6.4**	**15.9**	**8.8**	**7.1**

The second herd was studied December 24 to January 5, and the second test on the same herd was made January 21 to February 2. There were 16 animals tested, all of which were in both tests. These included four thoroughbred Jerseys, nine grade Jerseys, and one native. The average weight was 750 pounds, and, at date of first test, the average length of time since producing last calf was three months—and none were within four months of calving. The average age of the animals was seven years. The grain ration of the first test consisted of corn and cob meal, in about two parts, and imperial

wheat feed about one part. The total cost of the ration was 18.4 cents. By substituting old-process linseed meal for a part of the cob meal, and cutting down the total amount of the grain feed, the grain ration was cheapened nearly one cent per day. By increasing the amount of oat hay in the ration, and cutting down somewhat on the total amount of coarse fodder, a further saving was also made, so that, taken as a whole, the second ration cost 2½ cents per day less than the first ration. Although the second test was begun a month later than the first there was an increase in both the milk and butter product of the herd in favor of the second test.

DAIRY HERD F.—TESTS 31 AND 33.

Calculated per Head of 800 Pounds, Live Weight.

Feeding Stuffs.		Digestible Nutrients and Fuel Value.					Cost.	Value of Obtainable Manure.	Net Cost.
Kind.	Amount.	Protein.	Fat.	Carbohydrates.	Fuel Value.	Nutritive Ratio.			
First Test. *Feb. 4-16, 1895. 12 Days.*	Lbs.	Lbs.	Lbs.	Lbs.	Cal.	1:	Cts.	Cts.	Cts.
Grain, etc., Wheat middl'gs,	4.5	.72	.23	3.14	8200	5.1	6.3	2.8	3.5
Grain, etc., Corn & cob meal,	2.2								
Hays, etc., Corn ensilage,	34.9	.60	.42	7.72	17250	14.4	8.8	5.5	3.3
Hays, etc., Oat hay,	2.9								
Hays, etc., Corn stover,	2.9								
Hays, etc., Bog hay,	3.5								
Total food,	**50.9**	**1.32**	**.65**	**10.86**	**25450**	**9.3**	**15.1**	**8.3**	**6.8**
Second Test. *March 4-16, 1895. 12 Days.*									
Grain, etc., Wheat middl'gs,	3.9	1.14	.44	3.99	11400	4.4	8.3	5.0	3.3
Grain, etc., Cot. seed meal,	2.0								
Grain, etc., Corn & cob meal,	2.9								
Hays, etc., Clover hay,	10.0	1.09	.31	6.51	15450	6.6	9.7	6.0	3.7
Hays, etc., Oat hay,	1.9								
Hays, etc., Corn Stover,	1.9								
Hays, etc., Bog hay,	1.9								
Total food,	**24.5**	**2.23**	**.75**	**10.50**	**26850**	**5.5**	**18.0**	**11.0**	**7.0**

This herd was studied February 4–16, and again March 4–16. The animals in the test were the same in each case. Nine of the animals were grade Jerseys, and one a grade Ayrshire. The average weight of the herd was 800 pounds. At date of first test the average length of time since last calf was 4½ months, and none were within 5 months of calving. The

average age was 6½ years. The chief difference between the first ration and the second was the addition of cotton seed meal to the grain ration, and the substitution of clover hay for ensilage. The supply of ensilage on hand gave out soon after the close of the first test. Estimating the clover hay at $14 a ton, the second ration was considerably more expensive. Many farmers would not have estimated the clover hay at over $10 or $12 per ton. As it was, the second ration fed caused an increase in both the milk and butter product of the herd.

DAIRY HERD G.—TESTS 32 AND 34.

Calculated per Head of 775 Pounds, Live Weight.

Feeding Stuffs.		Digestible Nutrients and Fuel Value.					Cost.	Value of Obtainable Manure.	Net Cost.
Kind.	Amount.	Protein.	Fat.	Carbohydrates.	Fuel Value.	Nutritive Ratio.			
First Test. *Feb. 18–Mch. 2, 1895. 12 Days.*	Lbs.	Lbs.	Lbs.	Lbs.	Cal.	1:	Cts.	Cts.	Cts.
Grain, etc., Buf. gluten feed,	5.2	1.69	.83	3.24	12650	3.0	7.5	4.8	2.7
Grain, etc., Wheat bran, -	2.9								
Hays, etc., Hay, - - -	7.7	.45	.22	6.59	14050	15.8	9.2	4.3	4.9
Hays, etc., Corn stover, -	3.2								
Hays, etc., Corn fodder, -	3.3								
Total food, - - -	**22.3**	**2.14**	**1.05**	**9.83**	**26750**	**5.7**	**16.7**	**9.1**	**7.6**
Second Test. *Mch. 18–30, 1895. 12 Days.*									
Grain, etc., Wheat bran, -	4.0	1.59	.63	3.05	11300	2.8	7.5	5.8	1.7
Grain, etc., Cotton seed meal,	1.9								
Grain, etc., Buf. gluten feed,	2.0								
Hays, etc., Hay, - - -	1.8	.57	.22	6.94	14900	13.0	8.7	4.8	3.9
Hays, etc., Corn stover, -	2.9								
Hays, etc., Hungarian hay, -	5.3								
Hays, etc., Corn fodder, -	5.8								
Total food, - - -	**23.7**	**2.16**	**.85**	**9.99**	**26200**	**5.5**	**16.2**	**10.6**	**5.6**

This herd was first studied February 18–March 2, and again March 18–30. The animals were the same in each test. Six of the animals were grade Holsteins, three were grade Jerseys, three were pure Jerseys, and two were pure Guernseys. The average weight of the herd was 775 pounds. At the date of the first test, the average time since last calf was 5½ months. One animal was within six weeks of being due to calve, but none of the others were within four months of calving. The

first ration fed was found to be quite a narrow one, containing large quantities of protein—2.1 pounds daily for animals of 775 pounds, live weight. It was thought that the ration might be cheapened, which was done by substituting cotton seed meal for a part of the gluten. Although the second ration was fully as rich in protein as the first, and had as narrow a nutritive ratio, the animals failed to produce as much milk or butter on the second ration. The proportion of coarse fodders was considerably increased in the second ration, and this may account in part for the smaller milk and fat yields. It is interesting to note that the percentage of fat in the second ration was larger for every cow than in the first.

Summary of Daily Rations Fed, and Daily Milk and Butter Yield from Seven Herds with a Wide and a Narrower Ration.

Herd.	Average Weight of Cows.	No. of Test.	Daily Ration per Head.					Average Daily.		Cost of Food to Produce			
			Digestible Protein.	Fuel Value of Digestible Nutrients	Nutritive Ratio.	Total Cost.	Net Cost.*	Milk Flow.	Yield of Butter.†	100 lbs. Milk.		1 lb. Butter.	
										Total Cost.	Net Cost.*	Total Cost.	Net Cost.*
	Lbs.		Lbs.	Cal.	1:	Cts.	Cts.	Lbs.	Lbs.	$	Ct	Cts.	Ct
A { Wide ration,	825	18	2.15	32750	7.3	26.6	14.3	18.1	1.10	1.47	79	24	13
A { Nar. ration,	825	21	2.39	29400	5.7	21.7	9.8	18.9	1.12	1.15	52	19	9
Standard,‡ - -	825	–	2.06	25600	5.6	—	—	—	—	—	–	–	–
B { Wide ration,	750	20	1.49	25800	8 5	18.6	9.5	18.1	.90	1.00	53	21	11
B { Nar. ration,	750	23	2.01	24700	5.7	18.3	9.0	17.9	.92	1.03	50	20	10
Standard,‡ - -	750	–	1.88	23250	5.6	—	—	—	—	—	–	–	–
C { Wide ration,	725	22	1.38	21150	7.3	19.4	12.5	13.7	.67	1.41	91	29	19
C { Nar. ration,	725	25	1.80	22400	5.7	17.8	9.9	13.6	.71	1.30	73	25	14
Standard,‡ - -	725	–	1.81	22500	5.6	—	—	—	—	—	–	–	–
D { Wide ration,	600	27	1.29	21800	8.0	14.1	7.0	14.0	.79	1.01	50	18	9
D { Nar. ration,	600	29	2.09	25350	5.5	15.1	6.9	13.7	.76	1.10	50	20	9
Standard,‡ - -	600	–	1.50	18600	5.6	—	—	—	—	—	–	–	–
E { Wide ration,	750	28	1.63	30650	9.2	18.4	10.5	17.9	1.02	1.03	59	18	10
E { Nar. ration,	750	30	1.81	24950	6.4	15.9	7.1	18.3	1.07	.87	39	15	7
Standard,‡ - -	750	–	1.88	23250	5.6	—	—	—	—	—	–	–	–
F { Wide ration,	800	31	1.32	25450	9.3	15.1	6.8	17.8	1.01	.85	38	15	7
F { Nar. ration,	800	33	2.23	26850	5.5	18.0	7.0	18.5	1.04	.97	38	17	7
Standard,‡ - -	800	–	2.00	24800	5.6	—	—	—	—	—	–	–	–
G { First ration,	775	32	2.14	26750	5.7	16.7	7.6	17.7	.98	.94	43	17	8
G { Second ration	775	34	2.16	26200	5.5	16.2	5.6	15.4	.90	1.05	36	18	6
Standard,‡ - -	775	–	1.94	24050	5.6	—	—	—	—	—	–	–	–

* Total cost less value of obtainable manure.

† Assuming butter to contain 82.4 per cent. butter-fat and that 96.3 per cent. of the fat in the whole milk to be saved in the butter.

‡ Tentatively suggested standard of rations for animals of this weight.

SUMMARY OF RESULTS ON SEVEN HERDS.

The fourteen tests with seven herds are summarized in the preceding table. The rations fed each herd in the different tests, the cost of the rations, the daily milk and butter product, and the cost of food to produce 100 pounds of milk and one pound of butter, are given in such a way that the results from the two rations can be easily compared. From this table it will be seen that the narrow rations used, that is, those containing relatively large quantities of protein, were the cheaper and gave larger yields of milk and butter in the majority of cases. The greater cost of the rations in the case of herds A, B and C is due to the higher cost of grain feeds during the winter of 1893 and 1894.

THE EFFECT OF NARROW RATIONS ON MILK FLOW AND BUTTER YIELD.

At the time of the second test in each case the cows were four weeks farther along in the period of lactation, and would, in consequence, naturally have fallen off in milk flow and butter yield. It is impossible to say exactly how much this natural shrinkage would have been. In animals as near calving as some of these were the shrinkage would have been large; while in the case of cows in "flush," the decrease would have been less marked. From a record of a herd of native cows and Ayrshires, extending over 15 years, including 83 different animals and 210 calvings, the New York Experiment Station concluded that "the natural falling off in milk for each month from calving is about 9 per cent. of the yield of the preceding month." The shrinkage in butter yield would, of course, be less, because the milk grows richer in fat as the period of lactation advances.

From the summary of the past two winters' work it will be seen that there was an increase in the milk flow in three cases, when the animals were fed on the narrow ration, over that obtained when the animals were fed on the wide ration, and in three other cases the yields were practically the same, although in these cases the herds were four to six weeks further along in the period of lactation when the narrow ration was fed. Of the six herds which were fed the wider ration, followed by the narrower one, all except one gave an increase in butter yield during the second test.

Although a shrinkage in production would naturally follow from advancement in period of lactation, the herds as a whole more than held their own when changed to the narrower ration from four to six weeks after the first test. The results are in accord with the best observations and experiments, in that so far as physiological effects are concerned narrow (nitrogenous) rations give larger yields of both milk and butter than do wide (carbonaceous) rations.

COST OF THE RATIONS.

In the majority of cases the total cost of the narrow ration was considerably less than that of the wide ration. Some nitrogenous grain feed like cotton seed, gluten, or linseed, was, in most cases, substituted in the second tests for a part of the wheat and corn feeds used in the first rations, in order to increase the nitrogenous matter. The total cost of the rations and the net cost after deducting the manurial value is shown in the summary table. These show the total cost of feed and the net cost after deducting the manurial value, on the assumption that 85 per cent. of the nitrogen, phosphoric acid, and potash, of the fodders are obtainable in the manure and that they have the same value as in ordinary commercial fertilizers. The following tables give the cost of food to produce 100 pounds of milk, and one pound of butter.

Cost of Food to Produce 100 Pounds of Milk.

Herd.	Total Cost of Feed.		Net Cost of Feed.*	
	Wide Ration.	Narrower Ration.	Wide Ration.	Narrower Ration.
			Cents.	*Cents.*
A, - - - -	$1.47	$1.15	79	52
B, - - - -	1.00	1.03	53	50
C, - - - -	1.41	1.30	91	73
D, - - - -	1.01	1.10	50	50
E, - - - -	1.03	.87	59	39
F, - - - -	.85	.97	38	38
G, - - - -	1.05†	.94‡	43†	36‡
Average, - -	**1.12**	**1.05**	**59**	**48**

* Total cost less that of obtainable manure. † First ration. ‡ Second ration.

Cost of Food to Produce One Pound of Butter.

Herd.	Total Cost of Feed.		Net Cost of Feed.*	
	Wide Ration.	Narrower Ration.	Wide Ration.	Narrower Ration.
	Cents.	*Cents.*	*Cents.*	*Cents.*
A,	24	19	13	9
B,	21	20	11	10
C,	29	25	19	14
D,	18	20	9	9
E,	18	15	10	7
F,	15	17	7	7
G,	18†	18‡	8†	6‡
Average,	**20**	**19**	**11**	**9**

* Total cost less that of obtainable manure. † First ration. ‡ Second ration.

In cases where the coarse fodders used were similar in both the first and the second tests, the total cost of the second, or narrow ration, was generally less. When the net cost of food is taken into consideration, the narrower ration proved cheaper in all cases except two; in these the cost was the same for the narrow and wide rations. The lower net cost of the narrow rations is due to the fact that nitrogen is found in larger quantities in these rations. A large part of this nitrogen goes into the manure, and adds greatly to its value.

SUMMARY.—THE EXPERIMENTS AND RESULTS.

In the winter of 1892–93, the Station began making systematic observations of the winter feeding practices of Connecticut dairymen. The chief points upon which information was obtained were: Number of animals in the herd; breed, age, and approximate weight of each cow; length of time since dropping last calf and till due to calve again; kinds, weights, and chemical composition of feeding stuffs used; weights of milk flow; percentages and amounts of butter-fat in the milk.

The feeding stuffs used on these farms included quite a long list, but those that tend to make a wide ration were employed in much greater proportions than were those which tend to make rations narrow. The following is a nearly complete list. The nutritive ratios are calculated from the analyses made in the experiments taken, together with other analyses of like materials, as used in New England. The more nitrogenous materials are,

of course, those richest in protein or "flesh formers," while the more carbonaceous are those poorer in protein and having larger proportions of the fuel ingredients, i. e., fats, and especially the carbohydrates. The former, with smaller nutritive ratios (ratio or protein to fuel ingredients), tend to make narrow rations, while the latter make wide rations.

CLASSIFICATION OF FEEDING STUFFS USED IN THESE TESTS.

Nitrogenous Feeding Stuffs—Rich in Protein.	Nutritive Ratio.	Carbonaceous Feeding Stuffs—Poor in Protein.	Nutritive Ratio.
Cotton seed meal,	1.3	Corn fodder or ensilage,	8.5
Linseed meal,	1.8	Corn meal,	9.8
Cream gluten,	2.1	Corn and cob meal,	9.9
Gluten meal,	2.4	Roots (turnips, etc.),	9.5
Malt sprouts,	2.5	Potatoes,	13.0
Pea meal,	3.2	Hay, mixed grasses,	10.9
Gluten feed,	4.0	Red-top hay,	10.8
Wheat bran,	4.0	Timothy hay,	13.0
Wheat middlings,	4.2	Timothy and red-top hay,	11.5
Clover hay,	5.1	Oat hay,	11.0
Rowen hay,	5.3	Corn stover,	17.4

In 1892–93 sixteen herds were visited and a five-days' test was made with each. In 1893–94 six herds were visited, and in four instances the time of study of the feeding, management, and products of each herd was extended to twelve days. As soon as the analyses could be made the amounts of actual nutrients in the rations fed were calculated, and in three cases other rations were suggested. The feed was gradually changed to the suggested ration with these three herds, and after four weeks from the close of the first test another twelve-days' test was made with the new ration.

In 1894–95 four herds were studied on the same plan as in the longer studies made the previous winter, except that the length of time between the two tests, on the same herd, was shortened to two weeks.

In general, there was the largest yield of milk and the largest butter production with narrow rations, i. e., those rich in protein. Wide rations—low in protein—did not, in these instances, favor large milk or butter production.

In the tests of 1893–94, and of 1894–95, when it was possible to study the financial side of the feeding, narrow rations—rich in protein—were the more economical.

RATION FOR A MILCH COW.

A proper ration for a milch cow would furnish the nutrients needed to form the materials of the body and the milk, and the energy required to do the necessary muscular work and keep the body warm. Just what weights of digestible protein, fats, and carbohydrates will, as a general average, meet these needs is a matter of uncertainty. The following rations have been suggested as guides in the practical feeding of milch cows of a live weight of 1000 pounds:

	German (Wolff) "Standard Ration."	Wisconsin Station "Standard Ration."	Ration tentatively suggested by the Writers.
	Lbs.	Lbs.	Lbs.
Organic matter,	25.00	24.50	25.00
Digestible protein,	2.50	2.15	2.50
Digestible fats,	.40	.74	.5 to .8
Digestible carbohydrates,	12.50	13.27	13 to 12
	Calories.	Calories.	Calories.
Fuel value,	29,600	31,250	31,000
Nutritive ratio,	1:5.4	1:6.9	1:5.6

*The ration suggested by the writers is founded upon the physiological standard of Wolff, with allowance for the abundance and cheapness of foods of high fuel value, i. e., those rich in carbohydrates and fats, in the United States. The experience of the last two years would, however, indicate that, in general, it is more profitable to feed a cow in "the flush" rather more protein than the suggested ration calls for. The very decided trend of these experiments is toward nitrogenous feeding.**

FEEDING STANDARDS AND INTELLIGENT FEEDING.

The subject of cattle feeding is a broad one. The experimenter can only lay down broad, general principles. The right application in each case must depend upon the intelligence and care of the feeder. Specific rules to cover all cases and conditions are not known, nor are they possible. There is no "best ration" for milch cows or any other animals.

Different breeds and different animals of the same breed differ widely in their demands for food and the use they can make of the nutrients it furnishes. The food that is most profitable for a cow when she is giving the largest amount of milk might be very unprofitable for the same cow near the end of the period of

* Explanations of methods of calculating rations are given in the Report of this Station for 1893, pages 168–173.

lactation. Feeding stuffs of the same kind vary in composition, so that a given specimen may have more or less nutrients than the figures for average composition imply. They vary still more in cost, so that a given food material might be fed with large profit in one case and with equally large loss in another.

Different as are the above standards for feeding milch cows, it is probably true that three-fourths of the feeders in this State would find their herds give better returns if they should try to make the rations which they feed conform to either one of the three cited. This would follow not more from the improvement in the ration fed than from the increased attention to details in care and handling which would follow better attention to feeding.

Like other manufacturers, the dairyman must reduce the cost of production to keep up his profits. The minute economies have become necessities. Science can help the dairyman by giving him the results of its accurate experimenting, but, after all, the best it can do for him is to help him to help himself.

CONCLUSIONS.

The studies thus far made with Connecticut dairy herds, taken in connection with experience and experimenting elsewhere, seem to warrant the following conclusion:

First.—Our farmers need to make a much closer study of the individual cows of their herds and to reject the unprofitable ones. The relative productiveness of cows can be easily and cheaply studied by the use of the Babcock milk test, together with daily weighings of the milk product.

Second.—A closer study of the value and economy of the feeding stuffs produced on the farm is important. Such feeds as clovers, corn fodders, corn stover, oat hay, and peas and oats, should be more largely grown. These have little value in the markets, while, for feeding, many of them are fully equal to, and some more valuable than, the best grades of hay. When first-class hay sells for from fifteen to eighteen dollars per ton, it is one of the most expensive dairy feeds.

Third.—The nitrogenous (protein) feeding stuffs like clovers, cotton seed, linseed, and gluten meals, should be more extensively used as dairy feeds. These feeds have been shown to exert a greater influence on the quantity and quality of animal products than corn and even wheat feeds, and when the manure is carefully saved they are of great value for keeping up the fertility of the farm.

SOILING EXPERIMENTS WITH LEGUMINOUS AND CEREAL CROPS.

BY C. S. PHELPS.

PREVIOUS FEEDING EXPERIMENTS WITH GREEN FODDERS BY THE STATION.

During the summers of 1891 and 1892 the Station carried on a number of feeding tests with milch cows on different fodder crops. The object of the experiments was to study the values of different green fodders for milk and butter production, and the effects of the rations on the milk product, with especial reference to the quantity of fat produced. A small grain ration, mixed in most cases with cut hay or straw, was fed once a day. From fifty to seventy-five pounds daily per animal of the various green fodders were used.

Four cows were used in these earlier experiments, and were all fed the same kind of fodder during each individual period. In 1891 the feeding experiments were carried on from June 8th to September 22d, and were calculated in four-day periods, although the same fodder was fed from twelve to sixteen days in nearly all cases, thus making up two or three four-day periods. In two tests with Hungarian grass the amounts of feed were limited, and the fodder could only be fed for seven or eight days in each case, leaving but one four-day period for the test. In 1892 the experiments were carried on from May 29th to August 15th, and the test periods covered seven days. In each year three or four days were allowed as a preliminary period on each fodder, before the test was begun. All of the fodders were analyzed, although the digestion factors were assumed from the averages of work done elsewhere. In 1891 the fats only were determined, and in 1892 both fats and solids were determined in the milk.

The results in a general way pointed out quite forcibly the high value of nitrogenous green fodders, such as clovers, oats and peas, soy beans and cow peas for milk and butter production.

A summary of the work, essentially as published in Bulletin No. 9, is here given as an introductory to the experiments of 1895, which follow.

SOILING AND SOILING CROPS.

Under the soiling system more stock can be kept on a given acreage than by pasturing; much of the expense of fencing is saved; nearly all of the food given is available for the formation of milk and its constituents, as there is no waste of energy in searching for food, and the manure can be preserved free from waste.

The best crops for soiling are those rich in nitrogenous ingredients or protein. Although smaller crops are usually obtained with the legumes (clover, peas, etc.,) than with fodder corn, the fodder from the legumes is much richer in nitrogen, and hence of more value in the production of milk, cheese, butter and beef. That is to say, corn fodder makes a one-sided ration unless some considerable nitrogenous feeding stuff is used with it. The legumes are particularly valuable for furnishing the protein which is lacking in corn fodder, and likewise in corn meal, ordinary hay and straw. The legumes, being nitrogen collectors, are able to obtain much of their food supply from the air and subsoil. They add to the fertility of the soil by the decay of their roots, stubble and leaves, which are left in and upon the soil when the crop is harvested.

The more extended use of fodder crops like the clovers, field peas, cow peas, vetch and alfalfa, is a matter that should receive the thoughtful attention of farmers. These crops can all be grown in Connecticut, and with the exception of alfalfa have been successfully grown and fed at the Station during the past four years.

RESULTS OF FEEDING EXPERIMENTS WITH MILCH COWS AND SOILING CROPS, 1891 AND 1892.

The best results on quantity and quality of the milk were obtained where rations with relatively large amounts of protein were fed. The experiments seem to indicate that rations containing a larger proportion of digestible protein than that called for by the commonly accepted standards, are to be preferred. Rations rich in protein are especially important early in the

period of lactation, when the productive capacity of the cow is most heavily taxed. The quantity and quality of the milk may be improved by the use of foods rich in protein, and the manure is more valuable than where more starchy foods are used.

In these experiments, where clover was fed the amounts of milk and butter were considerably increased, and the percentages of fat were higher than during tests with Hungarian grass, which were made just before and after those with clover. The average four-days' product from four cows during the three periods of the clover tests (beginning August 10th, 14th and 18th) of 1891, was 281 pounds of milk and 15.6 pounds of butter, and the average percentage of fat in the milk was 5.3 per cent., while for the Hungarian tests (beginning August 3d and 27th) the average quantity of milk was 249 pounds, and of butter 12.9 pounds, and the average percentage of fat 5.0 per cent.

Of course such experiments as these, in which the number of cows and the number of tests were small, the periods short and the composition of the rations was not determined with the greatest accuracy, cannot give results as reliable as are to be desired. The conclusions are therefore to be taken with these things in mind. Their chief value is in the general confirmation they give of the value of green fodders rich in nitrogen and the advantages of their use in soiling.

EXPERIMENTS WITH LEGUMES AND CEREAL FODDER CROPS IN 1895.

During the summer of 1895 the Station carried out a series of feeding tests for the purpose of studying the relative values of green fodders high in protein, as compared to those low in protein. Those containing relatively large quantities of protein were oats and peas, clover, cow peas, soja beans, rowen grass, and peas and barley, while those belonging to the group containing relatively small quantities of protein were oat fodder, Hungarian grass and corn fodder.

Six animals were used in the experiments, three in each of two groups. An effort was made to get cows in nearly the same condition as regards amount of products. They were ordinary grade stock, bought from dairy farmers or taken from

the college herd. Each of the animals had calved within four months previous to the beginning of the tests. The following is a brief description of the animals:

No. 1.—A grade Jersey; weight about 700 pounds; about 4½ years old; calved March, 1895; not with calf at starting of test.

No. 2.—A Jersey and Guernsey cross; weight about 800 pounds; 8 years old; calved in March, 1895; not with calf at starting of test.

No. 3.—A pure Jersey; weight about 750 pounds; 8 or 9 years old; calved March, 1895; due to calve February or March, 1896.

No. 5.—Grade Jersey; weight about 700 pounds; 8 or 9 years old; calved April, 1895; not with calf at starting of test.

No. 6.—Grade Jersey; weight about 800 pounds; 8 years old; calved June 14, 1895; not with calf at starting of test.

No. 7.—Grade Jersey; weight about 800 pounds; 6 or 7 years old; calved May, 1895; not with calf at starting of test.

OBJECT AND PLAN OF EXPERIMENTS.

The object of the experiments was to study the relative effects of leguminous and cereal fodders on quantity of milk, and on total quantity of fats and solids in the milk. The plan of the experiment was to take two groups of cows as nearly alike in total yield of milk and of butter-fat as could be readily found, and to feed one group mainly on leguminous fodders, plants belonging to the clover family, and the other group on cereal fodders, or plants belonging to the grass family. At the beginning of the experiment both groups were fed on a similar ration, and the yields of milk and fat compared. The fodder used for this preliminary test was oats and peas. Then cows 1, 2 and 3 were continued on the same class of fodders as in the preliminary test, while cows 5, 6 and 7 were given cereal fodders, beginning with oat fodder.

The green fodders were in all cases hauled to the barn and fed in the mangers, a two-days' supply usually being weighed out at one time. A small grain ration was fed once each day in addition to the green fodders. This was the same for each of the animals during all of the time of the tests. The different fodders were fed in nearly every instance for a period of two weeks, and the test included the last nine days of this period. Five days of preliminary feeding preceded each test.

The following table (10) gives the percentage composition of the various green fodders, and of the wheat bran and corn meal, at the time of feeding.

TABLE 10.

*Percentage Composition of Green Fodders and Grain Feeds Used in Soiling Experiments.**

KINDS.	DATES OF SAMPLING.	Dry Matter.	Protein.	Fat.	Nitrogen-free Extract.	Fiber.	Ash.
		%	%	%	%	%	%
Oats and peas, - -	July 10 & 15, -	16.1	3.32	.98	6.32	3.82	1.66
Oat fodder, - -	July 10 & 15, -	19.7	2.67	1.00	8.72	5.35	1.90
Hungarian grass, -	Aug. 1 & 5, -	21.3	2.60	1.43	9.30	5.90	2.09
Soy bean fodder, -	Aug. 1 & 5, -	21.1	3.78	.86	8.48	5.50	2.52
Clover rowen, - -	Aug. 15 & 19, -	25.7	4.35	1.25	11.12	6.72	2.22
Hungarian grass, -	Aug. 15 & 19, -	26.2	2.41	.87	12.58	8.11	2.27
Soy bean fodder, -	Aug. 26 & 31, -	25.2	3.24	1.00	11.80	6.94	2.21
Sweet corn fodder, -	Aug. 28 & 31, -	20.6	1.70	.58	12.54	4.54	1.24
Cow pea fodder, - -	Sept. 12 & 16, -	20.0	3.29	.82	10.20	3.44	2.24
Sweet corn fodder, -	Sept. 12 & 16, -	21.7	1.97	.85	13.75	4.03	1.11
Sweet corn fodder, -	Sept. 24 & 28, -	18.8	1.79	.53	11.76	3.64	1.10
Soy bean fodder, -	Sept. 24 & 28, -	24.7	5.39	.89	10.58	5.21	2.60
Rowen grass, - -	Oct. 1 & 5, -	32.8	5.26	1.92	14.88	8.09	2.68
Barley and peas, -	Oct. 8, 11, 13 & 15, - -	19.5	3.90	.83	8.15	4.98	1.65
Wheat bran, - -	- - - -	90.4	18.81	5.53	55.08	7.00	3.99
Corn meal, - - -	- - - -	90.5	11.31	4.72	71.68	1.31	1.47

* The results of these analyses are given in detail in the last part of this Report under "Analyses of Fodders and Feeding Stuffs."

DIGESTION EXPERIMENTS WITH THE GREEN FODDERS.

In the feeding experiments with milch cows on green fodders previously made by this Station, we were obliged to assume figures for the proportion of digestible nutrients from averages of the results of experiments made elsewhere. The number of digestion experiments that have been made on green fodders is small, and a considerable error must necessarily result from using averages of so few tests. In order to increase the value of these experiments, and with the hope of adding to the general knowledge of the digestibility of feeding stuffs, digestion experiments with sheep were made on the same fodders and during the same time that the green crops were being fed to the cows. It has been found that the different ruminating animals digest very nearly the same proportions of nutrients from the

same kind and condition of fodder. Hence it is generally considered that the results of digestion experiments with sheep are quite applicable to cows. As digestion experiments with sheep are more conveniently made than with cows, sheep were chosen for these trials.

In determining the digestibility of any fodder the quantities of the various nutrients, protein, fat, etc., fed to the animal during a given period, and the quantities of the same nutrients found in the solid excrements are estimated by analysis, and the differences are taken as a measure of the amount of each nutrient digested by the animal.

In the following table are given the percentages of each of the nutrients of the various fodders which were digested. For example, in table 11, in the case of oats and peas, the figures 81.5 in the column headed "Protein," mean that 81.5 per cent. of the protein of the fodder as fed, was digested by sheep A and B.

TABLE 11.

*Percentage of Total Nutrients of the Green Fodders Actually Digested.**

KINDS OF FODDER.	No. of Exp.	Sheep.	Protein.	Fat.	Nitrogen-free Extract.	Fiber.	Ash.	Organic Matter.
			%	%	%	%	%	%
Oats and peas, - -	14	A & B,	81.5	73.6	66.4	57.5	35.0	67.9
Oat fodder, - - -	15	C & D,	75.3	69.9	63.1	60.2	44.8	64.5
Hungarian grass, - -	16	A & B,	69.3	83.5	70.1	74.4	58.3	72.2
Soja beans, - - -	17	C & D,	78.8	54.1	72.0	50.1	7.8	66.0
Clover rowen, - -	18	B & F,	61.9	61.3	65.3	52.6	43.4	60.8
Hungarian grass, - -	19	C & D,	61.3	61.2	67.8	71.3	58.7	68.1
Soja beans, - - -	20	B & F,	69.3	54.3	73.5	40.9	20.3	62.3
Sweet corn fodder, - -	21	C & D,	55.6	78.3	74.1	54.2	50.7	68.0
Sweet corn fodder, - -	22	B & F,	66.5	81.7	78.3	60.7	50.3	73.9
Cow peas, - - -	23	C & D,	74.0	59.4	84.2	57.5	23.9	76.0
Sweet corn fodder, - -	24	C & D,	63.3	78.0	79.1	65.1	50.3	74.6
Grass (rowen), - -	25	B & F,	71.7	52.9	67.8	63.8	45.2	66.4
Barley and peas, - -	7	C & D,	77.2	59.7	61.4	43.5	46.2	60.2

*The digestion experiments, the results of which are here given, are printed in detail further on in this Report.

Table 12, which follows, gives the percentages of the different nutrients actually digested.

TABLE 12.

Percentages of Digestible Nutrients in Green Fodders, Wheat Bran and Corn Meal Used in the Experiments.

KINDS.	DATES OF SAMPLING.	Organic Matter.	Protein.	Fat.	Nitrogen-free Extract.	Fiber.
		%	%	%	%	%
Oat fodder,	July 10 & 15,	11.42	2.00	.70	5.50	3.22
Oats and peas,	July 10 & 15,	9.83	2.71	.72	4.20	2.20
Hungarian grass,	Aug. 1 & 5,	13.90	1.80	1.19	6.52	4.39
Soy bean fodder,	Aug. 1 & 5,	12.31	2.98	.47	6.11	2.75
Hungarian grass,	Aug. 15 & 19,	16.32	1.48	.53	8.53	5.78
Clover rowen,	Aug. 15 & 19,	14.25	2.69	.77	7.26	3.53
Sweet corn fodder,	Aug. 28 & 31,	13.15	.95	.45	9.29	2.46
Soy bean fodder,	Aug. 28 & 31,	14.13	2.25	.54	8.67	2.84
Sweet corn fodder,	Sept. 12 & 16,	15.22	1.31	.69	10.77	2.45
Cow pea fodder,	Sept. 12 & 16,	13.49	2.43	.49	8.59	1.98
Sweet corn fodder,	Sept. 24 & 28,	13.21	1.13	.41	9.30	2.37
Soy bean fodder,	Sept. 24 & 28,	14.94	4.24	.48	7.62	2.60
Rowen grass,	Oct. 1 & 5,	20.02	3.77	1.01	10.08	5.16
Barley and peas,	Oct. 8, 11, 13 & 15,	10.68	3.01	.50	5.00	2.17
Wheat bran,		60.84	14.67	4.20	39.66	2.31
Corn meal,		72.65	7.60	4.47	60.21	.37

The kinds and weights of green fodders used per cow per day are given in the following table.

TABLE 13.

Kinds and Amounts of Green Fodders Used per Cow per Day. Dates of Feeding and Dates of Tests.

Periods.	DATES OF FEEDING PERIODS.	DATES OF ACTUAL TESTS.	GREEN FODDERS.			
			Cows 1, 2 and 3.		Cows 5, 6 and 7.	
			Kinds.	Lbs.	Kinds.	Lbs.
1,	June 26, July 2,	June 27, July 2,	Oats and Peas,	70	Oats and Peas,	70
2,	July 3–24,	July 16–24,	Oats and Peas,	70	Oat fodder,	70
3,	July 25, Aug. 10,	Aug. 2–10,	Soy beans,	70	Hungarian,	70
4,	Aug. 11–24*	Aug. 16–24*	Clover rowen,	70	Hungarian,	70
5,	Aug. 25, Sept. 7,	Aug. 30, Sept. 7,	Soy beans,	70	Corn fodder,	80
6,	Sept. 8–21,	Sept. 13–21,	Cow peas,	70	Corn fodder,	80
7,	Sept. 30, Oct. 12,	Oct. 4–12,	Rowen grass,	70	Corn fodder,	80
8,	Oct. 13–25,	Oct. 17–25,	Barley and Peas,	70	Barley and Peas,	70

* The second Hungarian test ended August 19, as there was no preliminary period.

THE RATIONS FED.

The feeding periods indicate the time through which each of the fodders was used. The last nine days of this period were in each case taken to represent the test; five days being allowed after a change of feed before beginning the test. Each feeding period thus includes a preliminary period and a test period. The column headed "Periods" simply gives the numerical order of the tests. Period 1 was a short preliminary period during which the yield of milk and butter-fat for the two groups was compared.

During most of the tests seventy pounds of the green fodders were used, together with a very small amount of grain feed for each animal per day. In the corn fodder tests the amount was increased to eighty pounds. This was found necessary in order to satisfy the wants of the animals.

The green fodders were weighed as soon as practicable after cutting, a two-days' supply usually being weighed at one time. In a few cases coarse butts of the fodders were not entirely eaten, and the nutrients in these were calculated as accurately as possible and deducted from the rations as fed. The grain ration consisted of two pounds of wheat bran and one pound of corn meal, daily. The grain feed was purposely made light, in order to obtain the maximum effect from the green fodders. Table 14 gives the rations fed. It will be noticed that the cereal fodders, rations 1, 3, 5, etc., in all cases contained relatively small quantities of protein, and hence the nutritive ratios were wide; while the leguminous fodders 2, 4, 6, etc., were in nearly all cases quite rich in protein and gave narrow nutritive ratios. Two conditions in regard to the leguminous fodders tended to increase the protein in the rations made up of such fodders, over those made up of the cereal fodders. The leguminous fodders when harvested were richer in protein, and in most cases this protein was more thoroughly digested than in case of the cereal fodders.

RESULTS OF THE EXPERIMENT.

The following table (14) gives the amounts of digestible nutrients fed in the different rations, as determined from the analyses of the fodders and the digestion factors obtained in the digestion experiments with sheep, together with the weights actually eaten.

TABLE 14.

Amounts of Digestible Nutrients and Potential Energy in the Rations Fed per Cow per Day.

No. of Ration.	Kinds of Feed.	Weight as Fed.	Total Dry Matter.	Digestible Nutrients.				
				Protein.	Fat.	Carbo-hydrates.	Fuel Value.	Nutritive Ratio.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cal.	1:
1	Oat fodder, - - -	70	13.79	1.40	.49	6.10	—	—
	Corn meal, 1 lb., Wheat bran, 2 lbs., } Grain,	3	2.72	.38	.13	1.63	—	—
	Total, - - -	—	16.51	1.78	.62	7.73	20305	5.0
2	Oats and peas, - -	70	11.28	1.90	.50	4.48	—	—
	Grain, - - - -	3	2.72	.38	.13	1.63	—	—
	Total, - - -	—	14.00	2.28	.63	6.11	18265	3.3
3	Hungarian grass, - -	70	14.91	1.26	.83	7.63	—	—
	Grain, - - - -	3	2.72	.38	.13	1.63	—	—
	Total, - - -	—	17.63	1.64	.96	9.26	24325	7.0
4	Soy bean fodder, - -	70	14.91	2.09	.33	6.20	—	—
	Grain, - - - -	3	2.72	.38	.13	1.63	—	—
		—	17.63	2.47	.46	7.83	—	—
	Refuse, - - - -	—	1.23	.16	.03	1.04	—	—
	Total, - - -	—	16.40	2.31	.43	6.79	18740	3.3
5	Hungarian grass, - -	70	18.34	1.04	.37	10.02	—	—
	Grain, - - - -	3	2.72	.38	.13	1.63	—	—
	Total, - - -	—	21.06	1.42	.50	11.65	26420	9.0
6	Clover rowen, - - -	70	17.98	1.88	.54	7.55	—	—
	Grain, - - - -	3	2.72	.38	.13	1.63	—	—
	Total, - - -	—	20.70	2.26	.67	9.18	24105	4.7
7	Sweet-corn fodder, - -	80	16.48	.76	.36	9.40	—	—
	Grain, - - - -	3	2.72	.38	.13	1.63	—	—
		—	19.20	1.14	.49	11.03	—	—
	Refuse, - - - -	—	1.14	.04	.02	1.08	—	—
	Total, - - -	—	18.06	1.10	.47	9.95	23380	9.1
8	Soy bean fodder, - -	70	17.64	1.58	.38	8.06	—	—
	Grain, - - - -	3	2.72	.38	.13	1.63	—	—
		—	20.36	1.96	.51	9.69	—	—
	Refuse, - - - -	—	2.70	.27	.04	1.79	—	—
	Total, - - -	—	17.66	1.69	.47	7.90	19820	5.3

TABLE 14.—*(Continued.)*

No. of Ration.	Kinds of Feed.	Weights as Fed.	Total Dry Matter.	Digestible Nutrients.				
				Protein.	Fat.	Carbohydrates.	Fuel Value.	Nutritive Ratio.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cal.	1:
9	Sweet-corn fodder,	80	17.36	1.05	.55	10.58	—	—
	Grain,	3	2.72	.38	.13	1.63	—	—
		—	20.08	1.43	.68	12.21	—	—
	Refuse,	—	1.91	.07	.04	1.80	—	—
	Total,	—	**18.17**	**1.36**	**.64**	**10.41**	**24590**	**8.7**
10	Cow pea fodder,	70	14.00	1.70	.34	7.40	—	—
	Grain,	3	2.72	.38	.13	1.63	—	—
	Total,	—	**16.72**	**2.08**	**.47**	**9.03**	**22650**	**4.9**
11	Sweet-corn fodder,	80	15.04	.90	.33	9.34	—	—
	Grain,	3	2.72	.38	.13	1.63	—	—
	Total,	—	**17.76**	**1.28**	**.46**	**10.97**	**22725**	**9.4**
12	Rowen grass,	70	22.96	2.64	.71	10.67	—	—
	Grain,	3	2.72	.38	.13	1.63	—	—
	Total,	—	**25.68**	**3.02**	**.84**	**12.30**	**32040**	**4.4**
13	Barley and peas,	70	13.35	2.10	.35	5.02	—	—
	Grain,	3	2.72	.38	.13	1.63	—	—
	Total,	—	**16.07**	**2.48**	**.48**	**6.65**	**19005**	**3.2**
	Suggested standard for cows of 750 lbs.,*	—	**18.00**	**1.87**	—	—	**23250**	**5.4**

* See page 61, this Report.

RESULTS OF THE EXPERIMENTS.

The results of the experiments somewhat in detail are given in the following tables.

In tables 15, 16, 17 and 18 the yields of milk, solids, and fat by each cow in each test (except the preliminary test) have been grouped in accordance with the two classes of fodders (leguminous and cereal) which were fed. In tables 19 and 20 the yields of milk, of fat, and of solids for each group of cows for each period, and the protein and fuel values of the rations fed are summarized. At the beginning of the experiment (period 1) each group was fed the same ration and again at the end (period 8).

TABLE 15.

Pounds of Milk and Fat and Percentages of Fat for Periods of Nine Days. Cows Fed on Cereal Fodders.

Periods.	Dates of Feeding Tests.	Kinds of Feed.	Cow No. 5.			Cow No. 6.			Cow No. 7.		
			Milk.	Fat.		Milk.	Fat.		Milk.	Fat.	
			Lbs.	%	Lbs.	Lbs.	%	Lbs.	Lbs.	%	Lbs.
2	July 16–24,	Oats, - -	125.0	4.47	5.58	113.3	4.07	4.60	128.1	4.51	5.79
3	Aug. 2–10,	Hungarian, -	129.6	4.49	5.83	112.5	4.13	4.65	130.7	4.70	6.14
4	Aug. 11–19,	Hungarian, -	115.0	4.81	5.55	106.8	4.47	4.77	123.2	4.68	5.79
5	Aug. 30—Sept. 7, -	Corn fodder, -	103.5	4.61	4.77	76.5	4.48	3.42	102.2	5.02	5.13
6	Sept. 13–21,	Corn fodder, -	87.2	5.4	4.71	74.3	4.7	3.46	95.4	4.9	4.72
7	Oct. 4–12,	Corn fodder, -	104.9	5.4	5.66	88.4	4.8	4.22	116.8	4.8	5.64
8	Oct. 17–25,	Barley and peas,	103.9	5.7	5.94	91.7	4.9	4.46	117.6	4.8	5.66

TABLE 16.

Pounds of Milk and Fat and Percentages of Fat for Periods of Nine Days. Cows Fed mainly on Leguminous Fodders.

Periods.	Dates of Feeding Tests.	Kinds of Feed.	Cow No. 1.			Cow No. 2.			Cow No. 3.		
			Milk.	Fat.		Milk.	Fat.		Milk.	Fat.	
			Lbs.	Av. %	Lbs.	Lbs.	Av. %	Lbs.	Lbs.	Av. %	Lbs.
2	July 16–24,	Oats and peas,	130.5	3.42	4.46	175.9	4.26	7.47	123.0	5.26	6.44
3	Aug. 2–10,	Soy beans, -	110.9	3.31	3.64	145.4	4.21	6.11	112.3	5.22	5.87
4	Aug. 16–24,	Clover, - -	117.7	3.66	4.31	134.6	4.50	6.05	107.5	5.50	5.87
5	Aug. 30—Sept. 7, -	Soy beans, -	117.6	3.47	4.21	121.6	4.31	5.23	102.3	5.24	5.36
6	Sept. 13–21,	Cow peas, -	124.2	3.4	4.29	90.9	4.4	3.97	96.9	5.7	5.46
7	Oct. 4–12,	Rowen, - -	129.6	3.6	4.70	124.1	4.7	5.86	93.6	5.7	5.36
8	Oct. 17–25,	Barley and peas,	140.0	3.4	4.71	117.3	4.6	5.35	81.9	5.7	4.67

TABLE 17.

Pounds of Milk and Solids and Percentages of Solids for Periods of Nine Days. Cows Fed on Cereal Fodders.

Periods.	Dates of Feeding Tests.	Kinds of Feed.	Cow No. 5.			Cow No. 6.			Cow No. 7.		
			Milk.	Solids.		Milk.	Solids.		Milk.	Solids.	
			Lbs.	%	Lbs.	Lbs.	%	Lbs.	Lbs.	%	Lbs.
2	July 16–24,	Oats, - -	125.0	12.86	15.98	113.3	12.72	14.36	128.1	13.06	16.72
3	Aug. 2–10,	Hungarian,	129.6	13.13	16.90	112.5	12.82	14.38	130.7	13.39	17.49
4	Aug. 11–19,	Hungarian,	115.0	13.41	15.28	106.8	12.80	13.72	123.2	13.38	16.52
5	Aug. 30—Sept. 7,	Corn fodder	103.5	13.17	13.65	76.5	13.05	9.97	102.2	13.70	14.00
6	Sept. 13-21	Corn fodder,	87.2	14.21	12.39	74.3	13.42	9.97	95.4	13.76	13.13
7	Oct. 4–12,	Corn fodder,	104.9	14.45	15.15	88.4	14.10	12.48	116.8	14.13	16.37
8	Oct. 17–25,	Barley & peas,	103.9	14.74	15.34	91.7	14.22	13.03	117.6	14.09	16.57

TABLE 18.—*Pounds of Milk and Solids and Percentages of Solids for Periods of Nine Days. Cows Fed mainly on Leguminous Fodders.*

Periods.	Dates of Feeding Tests.	Kinds of Feed.	Cow No. 1.			Cow No. 2.			Cow No. 3.		
			Milk.	Solids.		Milk.	Solids.		Milk.	Solids.	
			Lbs.	%	Lbs.	Lbs.	%	Lbs.	Lbs.	%	Lbs.
2	July 16–24,	Oats & peas,	130.5	12.03	15.67	175.9	12.40	21.76	123.0	13.90	17.06
3	Aug. 2–10,	Soy beans, -	110.9	11.91	13.18	145.4	12.50	18.12	112.3	13.92	15.62
4	Aug. 16–24,	Clover, -	117.7	12.35	14.40	134.6	12.52	16.83	107.5	13.96	14.98
5	Aug. 30—Sept. 7,	Soy beans,	117.6	12.41	14.60	121.6	12.33	14.98	102.3	13.70	14.01
6	Sept. 13–21,	Cow peas, -	124.2	12.26	15.19	90.9	12.45	11.30	96.9	14.45	14.02
7	Oct. 4–12,	Rowen, -	129.6	12.98	16.87	124.1	13.63	16.94	93.6	15.26	14.29
8	Oct. 17–25,	Barley & peas,	140.0	12.66	17.68	117.3	13.38	15.73	81.9	15.33	12.60

DISCUSSION OF THE RESULTS.

With the exception of the preliminary period at the beginning of the experiment, each of the fodders was fed two or more weeks, and the actual test covered the last nine days of this period. The milk was weighed at each milking, and a combined sample of the night's and morning's milk of each cow was taken for fat determinations by the Babcock test. A composite sample, covering two or three days, was also taken from each cow's milk, and determinations of the total solids of the milk were made three times weekly. These determinations were made regularly throughout the experiment, including the preliminary part of each feeding period. The daily yield of fat for each cow was calculated from the weight of each day's milk and the corresponding percentage of fat, and by adding the daily weights the total fat for nine days was obtained; and the yield of solids from each cow was obtained from the two or three days' yield of milk and the corresponding percentage of solids, and these two and three days' yields were added to obtain the total solids for nine days. The butter corresponding to the nine days' fat yields was obtained by adding one-sixth to the weight of the fat.

It will be noticed that the two lots of cows were quite uniform in the amounts of milk and of fat produced during the oat and pea period (1) when both lots had the same kind of fodder. As soon, however, as cows 5, 6 and 7 were given oat fodder in place of oats and peas, although the dry matter of the ration was larger than before, there was a marked falling off in products. This cannot be well accounted for except in the fact

that the oat fodder was much poorer in protein than the oats and peas. Cows 1, 2 and 3, which were continued on the oats and pea fodder, fell off but little in milk flow and amount of fat. Cows 5, 6 and 7 just about held their own during the Hungarian tests, but on the sweet-corn fodder rapidly fell off in amounts of milk and of fat. This was especially true in the first test with sweet corn. This lot of fodder was thickly planted, had a rather small proportion of ears, and in the digestion tests* was much less digestible than some of the later-fed lots. The increase in milk and fat made by these cows during the last corn fodder test, points out the higher value of the thinly sown, more mature corn fodder, as compared with immature or thickly sown fodder.

The results are summarized in tables 19 and 20, on page 90. The size of the rations fed is indicated by the total protein and fuel value. In all cases except one (period 5), the rations made up mainly of leguminous fodders contained larger quantities of digestible protein than our suggested standard (1.87 pounds for cows of 750 pounds live weight), while the rations made up of cereal fodders contained much less protein than the suggested standard. The milk flow seemed to be regulated largely by the amount of protein fed. In all cases, except the last corn fodder test, the cows fell off in milk flow whenever there was a considerable reduction in the quantity of protein fed—notice periods 1 and 2 and 4, 5 and 6, table 19,—and increased in milk flow whenever there was a considerable increase in the amount of protein—notice periods 6, 7 and 8, table 20. This tends to confirm the judgment expressed in connection with our winter feeding work,† that rations containing relatively more protein than that called for by the commonly accepted standards are to be preferred to those containing less protein.

It will be noticed that down to the end of the sixth test, cows 1, 2 and 3 fell off in milk flow and total fat gradually but less rapidly than cows 5, 6 and 7; and that in all cases except period 3, gave a larger amount of product than did cows 5, 6 and 7 in the corresponding periods. In the seventh feeding period, when rowen grass was fed, cows 1, 2 and 3 increased rapidly in the amount of milk and the quantity of

* With sheep described later in this Report. † Page 75 of this report.

fat over that produced during the cow-pea test shortly before. On the corn fodder rations, cows 5, 6 and 7 diminished in milk flow quite rapidly until the last period (7) that this kind of fodder was fed. In period 7 the corn fodder had a larger proportion of ears than the earlier-fed lots and proved more palatable to the animals, as shown by the fact that there was no refuse. The increase in milk during this period may be due to these conditions.

TABLE 19.—*Total Weights of Milk, Fat, and Solids, and the Percentages of Fat and Solids in Eight Periods of Nine Days each, by the Cows Fed on Cereal Fodders.*

Periods.	Kinds of Feed.	Digestible Nutrients per Day.		Cows 5, 6 and 7.					
		Protein.	Fuel Val.	Milk.	Fat.		Solids.		Butter.
		Lbs.	Cal.	Lbs.	Av. %	Lbs.	Av. %	Lbs.	Lbs.
1	Oats and peas, -	2.28	18265	467.4	4.00	19.3	—	—	22.5
2	Oat fodder, - -	1.75	20305	366.4	4.35	16.0	12.88	47.1	18.7
3	Hungarian, - -	1.64	24325	372.8	4.44	16.6	12.78	48.8	19.4
4	Hungarian, - -	1.42	26420	345.0	4.65	16.1	13.18	45.5	18.8
5	Corn fodder, - -	1.10	23380	282.2	4.70	13.3	13.31	37.6	15.5
6	Corn fodder, - -	1.36	24590	256.9	5.00	12.9	13.80	35.5	15.1
7	Corn fodder, - -	1.28	22725	310.1	5.00	15.5	14.23	44.0	18.1
	Totals, Periods 2–7,	**1.43***	**23625***	**1933.4**	—	**90.4**	—	**258.5**	**105.6**
8	Barley and peas, -	2.48	19005	313.2	5.10	16.1	14.35	45.0	18.8

* Average fed per day.

TABLE 20.—*Total Weights of Milk, Fat, and Solids, and the Percentages of Fat and Solids in Eight Periods of Nine Days each, by the Cows Fed mainly on Leguminous Fodders.*

Periods.	Kinds of Feed.	Digestible Nutrients per Day.		Cows 1, 2 and 3.					
		Protein.	Fuel Val.	Milk.	Fat.		Solids.		Butter.
		Lbs.	Cal.	Lbs.	Avg. %	Lbs.	Avg. %	Lbs.	Lbs.
1	Oats and peas, -	2.28	18265	462.3	4.23	19.6	—	—	22.9
2	Oats and peas, -	2.28	18265	429.4	4.31	18.4	12.78	54.5	21.5
3	Soy beans, - -	2.31	18740	368.6	4.25	15.6	12.78	46.9	18.2
4	Clover, - - -	2.26	24105	359.8	4.55	16.2	12.94	46.2	18.9
5	Soy beans, - -	1.69	19820	341.5	4.34	14.8	13.14	43.6	17.3
6	Cow peas, - -	2.08	22650	312.0	4.50	13.7	13.05	40.5	16.0
7	Rowen, - -	3.02	32040	347.3	4.70	15.9	13.96	48.1	18.6
	Totals, Periods 2–7,	**2.27***	**22610***	**2158.6**	—	**94.6**	—	**279.8**	**110.5**
8	Barley and peas, -	2.48	19005	339.2	4.60	14.7	13.79	46.0	17.2

* Average fed per day.

At the close of the experiment each group of cows was fed a ration similar to that fed at the start. Barley and peas were fed at the rate of seventy pounds per cow, daily. Cows 1, 2 and 3, which had been having a heavy protein ration, at once dropped off in quantity of products, although the barley and peas ration contained quite a large amount of protein, but considerably less than the rowen ration fed just before. Cows 5, 6 and 7 increased in amount of products on the barley and pea ration, although ten pounds less were fed than of the corn fodder. The following are the total yields for the two groups of cows for the periods 2 to 7, during which the feeds of the groups were different:

Groups of Cows.	Milk.	Solids.	Fat.	Butter.
	Lbs.	Lbs.	Lbs.	Lbs.
Cows 1, 2, and 3, fed mainly on leguminous fodders, - - - - - -	2159	280	95	111
Cows 5, 6, and 7, fed on cereal fodders, -	1933	259	90	106
Difference, - - - - - -	226	21	5	5

SUMMARY.

The object of the experiment was to compare fodders containing relatively large quantities of protein with those containing relatively small quantities, in their effects on milk and butter production. Those high in protein were mainly leguminous fodders, and consisted of oats and peas, clover, soy beans, cow peas, rowen, and barley and peas. Those lower in protein belonged to the cereal fodders, and consisted of oat fodder, Hungarian grass, and corn fodders. Seventy pounds of most of these crops were fed per cow daily, although eighty pounds of the corn fodders were used. Two pounds of wheat bran, and one pound of corn meal per cow were fed daily, in connection with the green fodders.

Two groups of cows, of three each, were chosen for the experiment. All of the cows had calved within four months previous to beginning the test. The green fodders were usually cut and hauled to the stable every other day; a two-days' supply being weighed at one time. The animals were stabled at night and fed in the mangers night and morning, and had the "run" of a small yard through the day.

Digestion experiments were made with sheep on the same fodders during the same time that they were being fed to the cows.

The amount of digestible nutrients was thus obtained from actual trials instead of by using averages of other experiments.

RESULTS OF THE EXPERIMENT.

The best results on quantity of products were obtained where rations with relatively large amounts of protein were fed. Although one-seventh larger rations of corn fodder were used than of those rations made up mainly of the legumes, the latter generally gave larger yields of both milk, of butter-fat, and of solids in the milk. The digestion experiments indicated that the legumes not only contain larger quantities of protein, when harvested, than the cereal fodders, but that they are also more thoroughly digested.

PRACTICAL APPLICATION.

As a rule, the best crops for summer feeding seem to be those rich in nitrogenous matter or protein. Although smaller crops are usually obtained with the legumes (clover, peas, soy beans, etc.,) than with fodder corn, the fodder from the legumes is richer in nitrogen and protein, and a larger percentage of this protein is digested by the animals, and hence these fodders are of more value in the production of milk, cheese, butter, and beef.

Owing to irregularities in pasture feed, caused mainly by frequent drouths, it becomes necessary to supplement such feed by the use of green fodders or silage, in order to prevent serious shrinkage in the amounts of milk, milk solids and butter-fat. A more extended use of fodder crops like the clovers, oats and peas, soy beans, cow peas and barley and peas, is a matter that should receive the careful attention of dairymen.

EXPERIMENTS ON FATTENING SHEEP.*

BY CHARLES E. LYMAN.

The feeding experiments with lambs for the winter of 1894–95 began December 1st, 1894. One hundred and forty ewe and wether lambs were selected out of a carload recently purchased in Buffalo. In selecting the lambs, the smaller ones were culled out, the object being to have them as nearly uniform in size as possible. They were all in good feeding condition; a few were fat.

METHOD OF FEEDING AND HANDLING.

The one hundred and forty lambs were placed in a large, sunny pen where they were given the following feed ration for one month. A mixture of corn ensilage and mixed grains was prepared every day in the proportion of one pound of ensilage to one pound of the mixed grains. The grain ration consisted of equal parts by weight of corn, culled peas, wheat bran, and whole wheat. The ensilage and grains were thoroughly mixed together, and the lambs were allowed all they would eat of the mixture twice a day. At noon they were given some loose hay—about what they would eat up clean. The hay was not weighed each day, but, at times during the month, a day's feed was weighed, so that a fairly accurate estimate could be made of what was eaten. The quantity of ensilage was estimated in the same way. It was handled in baskets, and was weighed at intervals during the month.

The amount of feed consumed for the month was: of the mixed grains, 5,200 pounds; ensilage estimated at 5,200 pounds; and hay estimated at 2,000 pounds.

* As stated in the report of the Director, on pages 7–13 of this Report, it is the policy of the Station to co-operate with farmers of the State in experiments upon the management of their farms and stock. While the Station has been conducting feeding experiments with sheep in its own barn at Storrs, it has seemed desirable to institute inquiries of a more immediately practical nature. For this purpose we are especially fortunate in the co-operation of Mr. Lyman, of Middlefield, who is, so far as we are aware, the most successful feeder of sheep on a large scale in Connecticut. The experiments reported herewith were made in Mr. Lyman's barn with lambs selected from a large number which he was feeding at the time. The analyses of the feeding stuffs and the calculations of the tables in Mr. Lyman's report were made by the Station. W. O. A.

The second month a change was made in the ration fed. Instead of 100 pounds of ensilage to 100 pounds of grain, as was fed the first month, the ensilage was reduced to about the proportion of 70 pounds of ensilage to 100 pounds of grain. The lambs were fed all they would eat of this mixture twice a day and what hay they would eat once a day as before. During the month of January they consumed of the mixed grains (corn, bran, wheat, and peas, equal parts by weight), 7,500 pounds; ensilage estimated at 5,600 pounds; and hay estimated at 2,000 pounds.

For the month of February the experiment was continued in the same line as in January, except that the wheat was left out of the ration, and corn, bran, and peas were fed in equal parts by weight. During February, the lambs consumed 6,960 pounds of grain; ensilage estimated at 5,250 pounds; and hay estimated at 1,800 pounds.

Table 21, which follows, contains the results of the analyses of the feeding stuffs used in the experiment, and table 22 shows the weights of grain, ensilage, and hay fed per animal, per day, during the three periods of one month each, and the nutrients which the daily ration contained. The fuel values of the rations are given in the last column.

TABLE 21.

Composition of Feeding Stuffs Used in the Experiments.

KIND.	Station No.	Water.	Protein.	Fat.	Carbohydrates.		Ash.
					Nitrogen-free Extract.	Fiber.	
		%	%	%	%	%	%
Wheat, - - - -	1378	10.7	13.5	1.9	71.0	1.5	1.4
Culled peas, - - -	1379	11.1	25.1	1.4	56.2	2.9	3.3
Wheat bran, - - -	1380	8.6	17.9	5.0	55.9	7.6	5.0
Corn meal, - - -	1381	14.1	9.6	5.2	68.4	1.1	1.6
Corn ensilage, - - -	1377	60.3	3.0	1.4	22.8	9.9	2.6
Average hay, - - -	*	24.7	6.2	2.7	37.7	24.7	4.0

* Average of New England grown mixed hay. Report of this Station, 1893, p. 148.

TABLE 22.

Average Weight of Feeding Stuffs and Nutrients Fed per Day to each Lamb during December, January and February.

Time of Experiment.	Kind of Food.	Total Food.	Nutrients.*					Fuel Value.	
			Organic Matter.	Protein.	Fat.	Nit.-free Extract.	Fiber.	As Calculated.†	As Determined.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cal.	Cal.
Dec. 1st to 31st, 1894,	Grain,	1.20	1.03	.20	.04	.75	.04	—	—
	Ensilage,	1.20	.44	.03	.02	.27	.12	—	—
	Hay,	.46	.33	.03	.01	.18	.11	—	—
	Total,	2.86	1.80	.26	.07	1.20	.27	3440	3825
Jan. 1st to 31st, 1895,	Grain,	1.74	1.49	.28	.06	1.09	.06	—	—
	Ensilage,	1.30	.49	.04	.02	.30	.13	—	—
	Hay,	.46	.33	.03	.01	.18	.11	—	—
	Total,	3.50	2.31	.35	.09	1.57	.30	4490	4945
Feb. 1st to 28th, 1895,	Grain,	1.80	1.56	.31	.06	1.13	.06	—	—
	Ensilage,	1.36	.51	.04	.02	.31	.14	—	—
	Hay,	.47	.33	.03	.01	.18	.11	—	—
	Total,	3.63	2.40	.38	.09	1.62	.31	4635	5080
Average, - -	—	**3.33**	**2.17**	**.33**	**.08**	**1.47**	**.29**	**4205**	**4615**

* The total nutrients are given instead of the weights of digestible nutrients. The market conditions are seldom such that wheat can be economically fed, and on this account no digestion experiments have ever been made with whole wheat. Last year wheat was so cheap that it was an economical cattle feed, but in the absence of all data it is not practicable to calculate the digestible nutrients in the rations here used.

† The calculated fuel values were obtained from the results of the analyses, assuming the fuel value of a pound of protein to be 1860 calories, a pound of fat 4220, and a pound of carbohydrates 1860 calories.

STATISTICS OF ANIMALS DURING THE EXPERIMENT.

At the beginning of the experiment (December 1, 1894), the 140 lambs weighed 10,000 pounds. At the close of the first month they were sheared and weighed again, the wool being weighed also. The weight of the wool was 666 pounds; the weight of the lambs after they were sheared, 9,925 pounds; total weight of lambs and wool, 10,591 pounds, a gain for the month of 591 pounds.

During the month of January two lambs died. Through an oversight their weights were not taken, but as they were small it was estimated to be 125 pounds for the two. The result for January was as follows: Weight of 140 lambs, January 1, 1895,

9,925 pounds; estimated weight of the two lambs that died, 125 pounds; weight of the 138 lambs, 9,800. Actual gain for January, 1,431 pounds.

The weight of 138 lambs, February 1, was 11,231 pounds; on March 1 the weight, including the weight of a lamb that it became necessary to butcher during the month, was 12,273 pounds, a gain for the month of 1,042 pounds. The lambs consumed of feed during the month of February, 6,960 pounds of grain; 5,250 pounds of ensilage, estimated weight; 1,800 pounds of hay, estimated weight. At this period the lambs had become so large and fat that it was decided to send them to the butchers, for fatter and larger ones would not suit the market where our lambs are sold.

Table 22 gives the average weight of the sheep at the beginning and end of each month, the gain in weight during the month, and the weights of total nutrients required to produce a gain of one pound in live weight.

TABLE 23.

Average Gain Per Sheep in Live Weight During December, January and February, and Pounds of Nutrients Required to Produce a Gain of One Pound in Live Weight During These Months.

Time of Experiment.	Average Weight.			Required to Produce a Gain of One Pound, Live Weight.						
				Total Nutrients.					Fuel Value.	
	At Start.	At Close.	Gain.	Organic Matter.	Protein.	Fat.	Nit.-free Extract.	Fiber.	Calculated	Determined.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cal.	Cal.
December, 1894, -	71.4	75.6*	4.2	13.25	1.93	.51	8.81	2.00	25,850	28,040
January, 1895, -	71.0	81.4	10.4	6.96	1.07	.27	4.72	.90	13,580	14,160
February,† 1895, -	81.4	89.7	8.3	8.93	1.43	.34	6.01	1.15	17,410	18,870
Average, - -	**74.6**	**82.2**	**7.6**	**9.71**	**1.48**	**.37**	**6.51**	**1.35**	**18,950**	**20,360**

* Includes weight of wool which was sheared during the month.

† The weights at end and the gain in weight for February are calculated for thirty-one days, so as to make the three periods comparable. The actual average weight February 28 was 88.9 pounds, and the gain for February 7.5 pounds.

DISCUSSION OF RESULTS.

Referring back to the first month of the feeding experiment, the question at once arises, What was the cause of the poor showing for the month? The trouble was with the ensilage,

which was very acid. The corn from which it was made failed largely to ear, on account of the drouth which prevailed during summer and fall of 1894. A great deal of the corn was actually drying up, and the last of August it was decided to cut it up and put it into the silo. The result proved that it was a grave mistake; a portion of the corn was immature and would have grown a great deal more had it been allowed to stand two or three weeks longer. It was this immature green corn that soured the whole lot and made it a very inferior feed for lambs. In stock feeding it is generally conceded that a certain amount of acid in the feed promotes digestion. An excess of acid, however, is injurious. This theory is well illustrated during the first two months of feeding. By increasing the relative proportion of grain to the ensilage, the difficulty was overcome. The lambs immediately took on a thrifty appearance, ate nearly half as much again of grain, besides taking 400 pounds more of ensilage during the second month than they did the first. As will be noticed, their gain for the first month was 4.2 pounds to the lamb, while they gained 10.4 pounds apiece the second month. In February the gain in weight was at the rate of 8.3 pounds to the lamb for a period of thirty-one days.

It would seem at first thought unfortunate that these feeding experiments should have been undertaken under such unfavorable circumstances. The inferior ensilage rendered it impossible to make the experiments in all respects successful, but we do not always acquire the most knowledge from our successes. One failure may in the end add more to our knowledge than many successful ventures.

METHODS PRACTICED IN HANDLING THE SHEEP.

I will now briefly sketch our methods of managing the flocks. We begin buying lambs in October or November. They all come from the stock yards in Buffalo. We aim to buy lambs from sixty to sixty-five pounds in weight, in good flesh, and with as much of "Down" blood in their veins as possible. We avoid the Merino, as well as the Leicester and Cotswold. The former will not make first-class mutton, and the latter are inclined to put on too much fat in proportion to the lean, besides not feeding well in large flocks. As soon as the lambs

arrive they are at once put into the feeding pen, and as soon as possible sheared; for we have found that they feed much better with the wool off their backs. They are then able to get rid of any ticks which may be troubling them.

The feeding pens are kept at as nearly a uniform temperature as possible during the whole winter, by means of ventilators, windows, and doors. We aim to keep the temperature at about 50° Fahrenheit. Our barn accommodates about 1,600 lambs with their wool on, and 2,000 or more with the wool off. The natural heat from the animals keeps the barn at the required temperature.

We begin selling lambs as soon as the market calls for them, which is sometimes in December, usually not till January. They are sold alive and shipped in car-load lots. As fast as the fat ones go, new ones are brought in from Buffalo to take their place, until about the 1st of March, when we stop buying.

NUMBER OF SHEEP IN EACH PEN.

We find it makes little difference how large a number are fed in a pen, provided there is room enough for them to move about the pens comfortably. Five hundred will do as well together as fifty. Of course small, weak, and timid lambs must be kept by themselves.

The question is often asked of sheepmen, How do you manage to keep so large a number of lambs in such close and confined quarters, without their becoming unhealthy and diseased? Our answer is that we never have any trouble from that source. The pens are kept dry by the use of coarse hay, using what is necessary to prevent, as far as possible, the formation of ammonia. We make it a point to clean out all accumulations, at least four times during the winter. Nothing can be more injurious to the growing animal than to be forced to breathe air loaded with gases arising from heating manure.

FEEDING.

This is a very important matter. In feeding lambs great care should be taken that no feed be left in the trough after their hunger is satisfied. There is another point in the feeding of lambs, which cannot be too strongly emphasized, namely, that the grain should be of the best quality. We

much prefer to pay two or three dollars a ton more for sweet bran, fresh from the mill, than to buy it in the summer, when the price is low, and run the chance of its becoming stale before we need to feed it. Ensilage that is in the slightest degree mouldy should never be offered them. Of all farm animals we think lambs are the most fastidious about their feed, and success in feeding largely depends upon the manner in which their feed is given them. All successful feeders are well aware that strict regularity in the hours of feeding is as essential in the feeding of lambs as it is in the management of any other kind of live stock.

After experimenting with nearly every variety of feed offered in the markets we have come to the simple ration of one-third corn, one-third peas or pea meal, and one-third wheat bran, by weight. If it is desired to put on fat faster, or if our stock of peas runs short, the corn is increased and the peas reduced. We do not like to reduce the bran, for we rely upon that to furnish the material for growing the bone of the animal. If we left bran entirely out of the ration, in a few weeks we should see many of the lambs hobbling about the pens scarcely able to get to their feeding troughs. Possibly if they had all the clover hay they would eat the bran might be dispensed with, but as we rarely have clover to feed them the bran is an absolute necessity with us.

In England, we are told, no farmer attempts to winter sheep without a supply of roots. In this country, owing to the peculiarities of the climate, it is difficult to raise roots cheaply. We have, however, a great advantage over our English cousins in being able to raise corn ensilage much cheaper than they can raise roots, which will not only take their place, but will also do away with the necessity of feeding large quantities of hay. We find that our lambs will eat the hay of the coarse wild grasses nearly if not quite as well as timothy hay. This enables the feeder to sell his better grades of hay, and at the same time make a profitable use of his straw, as well as his inferior and unsalable grades of hay.

We never feed the grain ration by itself when the lambs are in the barn to stay. It is all mixed with the corn ensilage before feeding. Sufficient feed for one day is prepared at a time, and is fed from baskets into troughs, which are so

constructed as to combine feed troughs and rack for hay. With good ensilage, that which is made from well-ripened corn, one pound of the mixed grain to one pound of ensilage is about the right proportion. This, with what hay they will eat once a day, should keep lambs thriving four or five months at any rate. How much longer they would thrive with this feeding we do not know. This we do know, however, that we have had them make as large a gain the fifth month of feeding as they did the first.

We consider it important that lambs should have plenty of salt, and water at all times; so each pen of lambs is provided with a tub into which fresh spring water is at all times flowing. They also have access to lumps of rock salt which are kept before them in their feeding racks.

As stated above we give mixed feed twice a day. It is fed in the following manner: The men with their baskets of feed begin at one end of the barn, and at first give the lambs about half what they know they will eat. By the time the lambs in the last pens are fed, the first are ready for more. It is often necessary to feed them three times, especially if the pens are crowded, and if all the lambs cannot get access to the troughs at the same time. With this method of feeding we never lose lambs from overeating, as would be sure to be the case if the grain was fed unmixed with coarse fodder.

MARKETING.

We sell our lambs to one firm of wholesale butchers, who have established a trade for them. We get a price quite a little in advance of the price paid for Western stock of the same stamp. They claim that our lambs are superior in having more lean meat in proportion to the fat, that the meat contains more of the natural juices, besides being more tender. This being the case, we are led to believe that our methods of feeding are superior to those usually practiced in the West.

FIELD EXPERIMENTS WITH FERTILIZERS.

BY C. S. PHELPS.

The field experiments conducted by the Station during the year 1895 have been carried out mainly on the Station land at Storrs. The coöperative soil tests on farms in different parts of the State, which have been an important part of our work in past years, have been discontinued owing to the press of work in other lines. It has been our experience that the soil tests have mainly a local value, and that many of our enterprising farmers can, with a little direction from the Station, carry out these experiments for themselves nearly or quite as well as if they were under the immediate supervision of an officer of the Station. For these reasons we have decided to give directions for the work wherever it may be desired, and leave all of the details to the person upon whose farm the test is to be made.

One experiment on corn on the farm owned by Ekonk Grange, which was started in 1894 was continued through the past year.

The field work with fertilizers has been mainly of three kinds, as follows:

1. Special nitrogen experiments on corn, legumes, and grasses, for the purpose of studying the effect of different quantities of nitrogen on the yield and composition of the crop.
2. A soil test by the Station at Storrs, and by Ekonk Grange at Ekonk.
3. Experiments on the improvement of light, "plain-land" soils by green manuring.

SPECIAL NITROGEN EXPERIMENTS.

In the fall of 1894 the plots on the field at the Station, that had been used for several years for special nitrogen experiments on grasses, were sub-divided into a number of smaller plots of one-fiftieth of an acre each, and experiments were planned for the purpose of comparing the effects of fertilizers on the yield and composition of two varieties of corn, and several varieties of legumes. Each of the smaller plots was to have the same treatment as regards kind and proportions of

fertilizers as the larger plots had received in the earlier experiments on grass. The plan of the experiment was to have a series of ten plots, two to be cropped without fertilizers, eight to have a fixed quantity in each case of mixed minerals—dissolved bone-black and muriate of potash. Of the eight fertilized plots, six were to receive different kinds and amounts of nitrogen. On three of these the nitrogen was applied in the form of nitrate of soda, supplying nitrogen at the rate of 25, 50 and 75 pounds per acre, and the other three were supplied with sulphate of ammonia furnishing nitrogen at the rate of 25, 50 and 75 pounds per acre.

Owing to the smallness of the plots it cannot be expected that the experiment will prove as valuable as regards the effect of fertilizers on yields as might be obtained on larger plots. It was thought, however, that the most important part of the experiment would be the effects of fertilizers on composition, and that the results would be nearly as valuable from smaller plots as from larger, and a greater number of crops could thus be experimented upon.

EXPERIMENTS ON CORN.

For the purpose of studying the effects of fertilizers and of breeding on the composition of corn, two varieties, differing quite widely in composition, were chosen. In one variety the seed used contained relatively large quantities of protein, 13.0 per cent. in the dry matter, while the other variety was known as poor land corn, and contained relatively small quantities of protein, 11.2 per cent. in the dry matter. It is planned to grow these two varieties on similar plots of ground through a series of years, using the same fertilizers from year to year, and to save seed from each plot and plant it again on the same plot the following year. It will be noticed that the crop on two plots is grown entirely without fertilizers, on two more with only mineral fertilizers, and on the other six with different amounts of nitrogen, varying from 25 to 75 pounds per acre. The two varieties were planted at opposite ends of the field, and as one was about ten days earlier than the other, it was thought that the seed would not mix. A slight amount of mixing did occur, however, but it is hoped that this condition may be avoided another season by planting one variety early and the other late.

TABLE 24.—SPECIAL NITROGEN EXPERIMENT ON CORN.

Weight and Cost of Fertilizers per Acre, Total Crop and Increase of Crop over that of the Nothing Plots.

Plot No.	Fertilizers.	Weight of Fertilizers.	Cost of Fertilizers.	Yield per Plot. 1-50 Acre.		Percentage Shelled Corn.	Yields per Acre. Shelled Corn. 11 % Water.		Stover per Acre. 25 % Water.	Gain over Nothing Plots.
				Corn (ears).	Stover.					
		Lbs.	$	Lbs.	Lbs.	%	Lbs.	Bu.	Lbs.	Bu.
0	Nothing,	—	—	70.7	58	73	2059	37	2749	—
7	Mixed Minerals, as No. 6*a*,	480	12.00	119.6	89	73	3522	63	4005	30
	Nit. of Soda (25 lbs. N.),	160								
8	Mixed Minerals, as No. 6*a*,	480	15.96	132.0	76	74	3969	71	3684	38
	Nit. of Soda (50 lbs. N.),	320								
9	Mixed Minerals, as No. 6*a*,	480	19.92	143.0	107	74	4490	80	4437	47
	Nit. of Soda (75 lbs. N.),	480								
6*a*	Dis. Bone-black, } M'xd	320	8.00	86.8	86	73	2589	46	3692	13
	Mur. of Potash. } Min.,	160								
10	Mixed Minerals, as No. 6*a*,	480	12.44	114.8	90	75	3693	66	3996	33
	Sulph. of Am. (25 lbs. N.),	120								
11	Mixed Minerals, as No. 6*a*,	480	16.88	123.3	101	73	3840	69	4128	36
	Sulph. of Am. (50 lbs. N.),	240								
12	Mixed Minerals, as No. 6*a*,	480	21.32	115.4	103	73	3638	65	4415	32
	Sulph. of Am. (75 lbs. N.),	360								
00	Nothing,	—	—	57.3	61	71	1645	29	3261	—
6*b*	Mixed Minerals, as No. 6*a*,	480	8.00	102.8	100	73	3040	54	4307	21

TABLE 25.—SPECIAL NITROGEN EXPERIMENT ON CORN.

Weight and Cost of Fertilizers per Acre, Total Crop and Increase of Crop over that of the Nothing Plots.

Plot No.	Fertilizers.	Weight of Fertilizers.	Cost of Fertilizers.	Yield per Plot. (1-50 Acre.)		Percentage Shelled Corn.	Yield per Acre		Stover per Acre. 25 % Water.	Gain Over Nothing Plots.
				Corn (ears).	Stover.		Shelled Corn. 11 % Water.			
		Lbs.	$	Lbs.	Lbs	%	Lbs.	Bu.	Lbs.	Bu.
0	Nothing,	—	—	76.0	47	78	2463	44	2393	—
7	Mixed Minerals, as No. 6*a*,	480	12.00	115.2	90	78	3816	68	3864	27
	Nitrate of Soda (25 lbs. N.),	160								
8	Mixed Minerals, as No. 6*a*,	480	15.96	118.8	84	80	3977	71	3349	30
	Nitrate of Soda (50 lbs. N.),	320								
9	Mixed Minerals, as No. 6*a*,	480	19.92	127.1	86	79	4159	74	3549	33
	Nitrate of Soda (75 lbs. N.),	480								
6*a*	Dis. Bone-black, } Mixed	320	8.00	80.9	81	79	2617	47	3727	6
	Mur. of Potash, } Min.,	160								
10	Mixed Minerals, as No. 6*a*,	480	12.44	105.8	92	79	3485	62	3741	21
	Sulph. Ammonia (25 lbs. N.),	120								
11	Mixed Minerals, as No. 6*a*,	480	16.88	119.9	105	80	4022	72	4123	31
	Sulph. Ammonia (50 lbs. N.),	240								
12	Mixed Minerals, as No. 6*a*,	480	21.32	115.1	103	78	3753	67	4381	23
	Sulph. Ammonia (75 lbs. N.),	360								
00	Nothing,	—	—	65.9	49	77	2127	38	2463	—
6*b*	Mixed Minerals, as No. 6*a*,	480	8.00	110.5	99	81	3738	67	4284	23

The fertilizer was applied broadcast on May 30, and the two varieties of corn were planted May 31, in check rows, three feet each way. Throughout the season it was noticed that the growth of corn on the nothing plots was small and pale in color. The mixed mineral plots, 6*a* and 6*b*, made nearly as heavy a growth of stalks as the plots having nitrogen, but the plants were lighter colored, and did not develop as heavy a growth of ears. The nitrogen plots were much alike, except that the growth of both ears and stalks seemed to be slightly heavier on the plots where the largest quantities of nitrogen were used.

Tables 24 and 25, on the preceding page, give the yields of both corn and stover on the two series of plots for the two varieties of corn. The water in both the corn and the stover from each plot was determined, so that the yields per acre are given on the basis of a uniform quantity of water in the case of each plot.

It will be noticed that there is quite a marked increase in yield on the nitrogenous plots over that where only mineral fertilizers were used. The mineral fertilizers alone gave but a slight increase over that obtained where no fertilizer was used. This was true with both the corn and the stover. The percentage of shelled corn was also greatest in most cases where nitrogen was applied to the crop.

EXPERIMENT ON COW PEAS.

Another series of plots similar to those on which the corn was grown, was planted to cow peas. The size of the plots, and the kinds and amounts of fertlilzers used were exactly the same as on the corn plots. The seed was planted in drills three feet apart, May 31, and was kept free from weeds by frequent cultivation. The growth until the latter part of the season appeared much the same on all of the plots except those having no fertilizer. Toward the latter end of the season (Sept. 3) it was noticed that the growth on plots 11 and 12, where sulphate of ammonia was used in the larger amounts, was not as heavy nor as dark colored as on the adjoining plots. An examination of the roots indicated that the proportion of root tubercles was much less on these two plots than on most of the others. After the crop was harvested a thorough examination of the roots was made on each of the plots, and the following notes were made.

On the roots of stubble left on plots 6*a*, 6*b*, 8 and 9, tubercles abundant. On plots 7 and 10, tubercles quite abundant. Plots 11 and 12, fewer tubercles than on the other plots. From these notes it will be seen that of the fertilized plots having nitrogen in the fertilizer used, the smallest yields were obtained where the fewest tubercles were found. It is also of interest to note that the yields on the mineral plots were fully equal to those obtained where nitrogen was used in addition to the minerals. In fact, the largest yield obtained was 6*a*, where only minerals were applied. The yields of the green crop per plot as harvested, and the yields per acre for each plot on the basis of 80 per cent. water, are given in the following table. It will be noticed that the yields on the fertilized plots are entirely independent of the quantities of nitrogen used. This tends to confirm our experience with this crop in past years; indicating that the crop can be readily grown on soils of moderate fertility, without the use of nitrogenous fertilizers.

TABLE 26.

SPECIAL NITROGEN EXPERIMENT ON COW PEA VINES.

Weight and Cost of Fertilizers per Acre, Total Crop and Increase of Crop over that of the Nothing Plots.

Plot No.	Fertilizers.	Weight of Fertilizers.	Cost of Fertilizers.	Cow Pea Vines.			Gain or Loss (–) over Nothing Plots.
				Yield per Plot. 1-50 Acre.	Yield per Acre. 80 % Water.		
		Lbs.	$	Lbs.	Lbs.	Tons.	Tons.
0	Nothing,	—	—	222	10435	5.2	—
7	Mixed Minerals, as No. 6*a*,	480	12.00	451	20635	10.3	5.0
	Nitrate of Soda (25 lbs. N.),	160					
8	Mixed Minerals, as No. 6*a*,	480	15.96	468	20825	10.4	5.1
	Nitrate of Soda (50 lbs. N.),	320					
9	Mixed Minerals, as No. 6*a*,	480	19.92	472	20885	10.4	5.1
	Nitrate of Soda (75 lbs. N.),	480					
6*a*	Dissolved Bone-black } Mixed	320	8.00	443	22595	11.3	6.0
	Muriate of Potash, } Minerals	160					
10	Mixed Minerals, as No. 6*a*,	480	12.44	447	20450	10.2	4.9
	Sulphate of Ammonia (25 lbs. N.),	120					
11	Mixed Minerals, as No. 6*a*,	480	16.88	429	18660	9.3	4.0
	Sulphate of Ammonia (50 lbs. N.),	240					
12	Mixed Minerals, as No. 6*a*,	480	21.32	438	19270	9.6	4.3
	Sulphate of Ammonia (75 lbs. N.),	360					
00	Nothing,	—	—	228	10715	5.4	—
6*b*	Mixed Minerals, as No. 6*a*,	480	8.00	434	20400	10.2	4.9

EXPERIMENT ON SOY BEANS.

Two series of plots similar to those upon which the corn and cow peas were grown, were planted to soy beans. For reasons given below, the crops on similar plots of two series of experiments were combined and the yields are given as one series of plots (1–25 acre each) in the following table:

TABLE 27.

SPECIAL NITROGEN EXPERIMENT ON SOY BEANS.

Weight and Cost of Fertilizers per Acre, Total Crop and Increase of Crop over that of the Nothing Plots.

Plot No.	Fertilizers.	Weight of Fertilizers.	Cost of Fertilizers.	Soy Beans (Seed).			Gain or Loss (–) over Nothing Plots.
				Yield per Plot, 1-25 Acre.	Yield per Acre. 11 % Water.		
		Lbs.	$	Lbs.	Lbs.	Bu.	Bu.
0	Nothing,	—	—	25.1	642	10.7	—
7	Mixed Minerals, as No. 6*a*, + Nitrate of Soda (25 lbs. N.),	480 + 160	12.00	30.8	781	13.0	2.4
8	Mixed Minerals, as No. 6*a*, + Nitrate of Soda (50 lbs. N.),	480 + 320	15.96	41.1	1051	17.5	6.9
9	Mixed Minerals, as No. 6*a*, + Nitrate of Soda (75 lbs. N.),	480 + 480	19.92	39.1	990	16.5	5.9
6*a*	Dissolved Bone-black + Muriate of Potash, Mixed Minerals	320 + 160	8.00	27.9	701	11.7	1.1
10	Mixed Minerals, as No. 6*a*, + Sulphate of Ammonia (25 lbs. N.),	480 + 120	12.44	36.5	929	15.5	4.9
11	Mixed Minerals, as No. 6*a*, + Sulphate of Ammonia (50 lbs. N.),	480 + 240	16.88	39.0	973	16.2	5.6
12	Mixed Minerals, as No. 6*a*, + Sulphate of Ammonia (75 lbs. N.),	480 + 360	21.32	42.9	1082	18.0	7.4
00	Nothing,	—	—	26.4	631	10.5	—
6*b*	Mixed Minerals, as No. 6*a*,	480	8.00	36.5	920	15.3	4.7

It was planned to use upon one series of plots a few hundred pounds of soil taken from a plot of ground where this crop had been grown the previous year, and where tubercles had developed freely. This was done in order to inoculate the new soil and cause the tubercles to develop. The crop on the other series of plots was to be grown without the addition of the extra soil. The soil was not applied until about the middle of July, at which time no tubercles could be found on the roots of the soy beans on any of the plots. It was thought that it would be of interest to ascertain if the soil might be inoculated near the middle of the season and the tubercles become sufficiently

developed to affect the growth. The growth of tubercles was small on all of the plots to which soil was applied, but no tubercles were found on plots to which no soil was added. The tubercles developed on the roots near the surface and seemed to show that the soil from the 1894 soy bean field had not been applied early enough to thoroughly inoculate the soil and allow the tubercles to develop sufficiently to materially affect the growth. On the whole, the yields where the additional soil was used were not materially different from those where no soil was added. This is probably due to the fact that the tubercles did not make sufficient growth to influence the acquisition of nitrogen.

SOIL TEST EXPERIMENT BY THE STATION.

This experiment is the sixth in a series planned as a rotation soil test experiment, the same fertilizers being used on the same plots year after year. Beginning with 1890 the crops grown on this field have been corn, potatoes, oats, cow peas, corn, and potatoes.

ARRANGEMENT OF PLOTS IN STATION EXPERIMENT.

UNMANURED STRIPS SEPARATE THE PLOTS.

EAST.

NORTH.		SOUTH.
Plot 0.		Plot Y.
Plot A.		Plot X.
Plot B.		Plot 000.
Plot C.		Plot G.
Plot 00.		Plot F.
Plot D.		Plot E.
Plot E.		Plot D.
Plot F.		Plot 00.
Plot G.		Plot C.
Plot 000.		Plot B.
Plot X.		Plot A.
Plot Y.		Plot 0.

WEST.

The field slopes gently to the south, but not enough to cause serious washing. The soil is a heavy loam, and the subsoil is a yellow, clay loam. In 1889 it was noticed that the soil

seemed to be poorer toward the west side of the field. For this reason the field was laid out into two half-acre experiments, the order of the plots on the two being reversed, as per diagram.

The yields of the duplicate plots in each case are added in estimating the yield per acre. This helps to eliminate the errors due to irregularities of soil. Beside the regular soil test, two other plots were added—one (X) with a medium amount (12,000 pounds) of manure, and in addition dissolved bone-black at the rate of 160 pounds per acre; the other (Y) with a larger quantity (16,000 pounds) of stable manure, but without bone-black.

In 1895 this field was planted to potatoes in drills 3.3 feet apart, on the 6th of May. The crop made a fair growth during the earlier part of the season, but about the 18th of July the crop was attacked by blight. Bordeaux mixture was at once applied to the vines on all of the plots. Although the progress of the disease was checked somewhat, it gradually spread over the entire field. On the 1st of August some notes were made regarding this experiment which may be of interest as showing the progress of the disease where no fertilizers, and where different kinds of fertilizers were used. On the Nothing plots the blight was noted to be quite bad—vines one-sixth to one-eighth dead. On all of the fertilized plots having no potash the blight was found to be making rapid progress, while on the plots having fertilizers with potash, the blight was found to have made but little progress, and the growth of vines was quite vigorous. On August 19th it was noticed that the vines on plots O, A, B and D, were nearly all dead. On plots C, E, F and G, where potash was used, crops on the plots were about one-half to two-thirds dead. The soil on this field has been observed to be rather deficient in potash during the past three or four years. This seems not only to have lessened the crop where potash was omitted, but in the case of the potatoes, the plants when grown without potash seemed to have a weakened condition which appeared to favor the development of the blight.

The crop as reported in the following table will be noticed to be quite light on all of the plots. This is due to the fact that the blight killed the vines before the crop had made its full growth.

TABLE 28.

SOIL TEST EXPERIMENTS WITH FERTILIZERS ON POTATOES.

BY THE STATION AT STORRS.

Plot No.	Fertilizers per Acre.			Yield per Plot. 1-12 Acre.			Yield per Acre.			
	Kind.	Weight.	Cost.	Large.	Small.	Total.	Large.	Small.	Total.	Gain over Nothing Plots.
		Lbs.	$	Lbs.	Lbs.	Lbs.	Bu.	Bu.	Bu.	Bu.
o	Nothing, - -	—	—	157.0	116.0	273.0	31.4	23.2	54.6	—
A	Nitrate of Soda, -	160	3.96	143.0	106.0	249.0	28.6	21.2	49.8	2
B	Dis. Bone-black,	320	4.40	162.0	116.5	278.5	32.4	23.3	55.7	8
C	Mur. of Potash, -	160	3.48	350.5	88.5	439.0	70.1	17.7	87.8	40
oo	Nothing, - -	—	—	93.5	98.0	191.5	18.7	19.6	38.3	—
D	Nitrate of Soda, -	160	8.48	173.5	113.5	287.0	34.7	22.7	57.4	10
	Dis. Bone-black,	320								
E	Nitrate of Soda, -	160	7.52	428.0	91.5	519.5	85.6	18.3	103.9	57
	Muriate of Potash,	160								
F	Dis. Bone-black,	320	8.00	457.0	87.0	544.0	91.4	17.4	108.8	61
	Muriate of Potash,	160								
G	Nitrate of Soda, -	160	12.00	547.5	99.0	646.5	109.5	19.8	129.3	82
	Dis. Bone-black,	320								
	Muriate of Potash,	160								
ooo	Nothing, - -	—	—	138.5	108.5	247.0	27.7	21.7	49.4	—
X	Stable Manure, -	10000	18.80	436.5	114.5	551.0	87.3	22.9	110.2	63
	Dis. Bone-black,	160								
Y	Stable Manure, -	16000	19.20	492.5	132.5	625.0	98.5	26.5	125.0	78

The yields obtained on this field during the past six years are shown in the following table:

Yields on Station Soil Test Experiment for past Six Years.

No. of Plot.	Fertilizers.	Lbs. per Acre.	Corn. 1890.	Potato's 1891.	Oats. 1892.	Cow Peas (vines). 1893.	Corn. 1894.	Potato's 1895.
			Bu.	Bu.	Bu.	Lbs.	Bu.	Bu.
o	Nothing, - -	—	28.9	89	29.1	10,230	33.6	55
A	Nitrate of Soda, -	160	32.4	105	36.0	10,960	41.0	50
B	Dis. Bone-black, -	320	33.3	97	27.0	10,710	37.6	56
C	Muriate of Potash, -	160	30.4	171	26.3	11,680	40.8	88
oo	Nothing, - -	—	26.7	87	24.2	9,725	28.0	38
D	Nitrate of Soda, -	160	36.1	110	37.9	12,920	40.8	57
	Dis. Bone-black, -	320						
E	Nitrate of Soda, -	160	32.8	160	30.0	13,335	47.6	104
	Muriate of Potash, -	160						
F	Dis. Bone-black, -	320	34.4	214	27.8	15,790	48.2	109
	Muriate of Potash, -	160						
G	Nitrate of Soda, -	160	37.4	259	39.4	16,210	58.2	129
	Dis. Bone-black, -	320						
	Muriate of Potash, -	160						
ooo	Nothing, - -	—	28.5	88	22.5	12,100	38.0	49
X	Stable Manure, -	12000	44.1	210	40.9	15,795	57.0	110
	Dis. Bone-black, -	160						
Y	Stable Manure, -	16000	43.6	250	41.3	15,875	56.7	125

EXPERIMENT BY EKONK GRANGE.

This experiment is the same as the one conducted in 1894 on the farm owned by this grange.*

TABLE 29.—SOIL TEST WITH FERTILIZERS ON CORN.

BY EKONK GRANGE.

Plot No.	Fertilizers per Acre. Kind.	Weight.	Cost.	Yield per Plot. 1-10 Acre. Ears. Good.	Ears. Poor.	Stover.	Yield per Acre. Shelled Corn. 11% Water. Good.	Shelled Corn. 11% Water. Poor.	Stover.	Gain or Loss (-) over Nothing Plots.
		Lbs.	$	Lbs.	Lbs.	Lbs.	Bu.	Bu.	Lbs.	Bu.
o	Nothing,	—	—	48	14	126	5.6	1.6	1260	—
A	Nitrate of Soda,	160	3.96	53	8	143	6.2	.9	1430	−5.4
B	Dissolved Bone-black,	320	4.40	59	14	136	6.9	1.6	1360	−4.0
C	Muriate of Potash,	160	3.48	86	20	195	10.0	2.3	1950	−0.2
D	Nitrate of Soda,	160	8.48	121	22	187	14.1	2.6	1870	4.2
	Dis. Bone-black,	320								
E	Nitrate of Soda,	160	7.52	114	18	224	13.3	2.1	2240	2.9
	Muriate of Potash,	160								
F	Dis. Bone-black,	320	8.00	238	24	297	27.7	2.8	2970	18.0
	Muriate of Potash,	160								
G	Nitrate of Soda,	160	12.00	231	29	307	26.9	3.4	3070	17.8
	Dis. Bone-black,	320								
	Muriate of Potash,	160								
oo	Nothing,	—	—	61	40	148	7.1	4.7	1480	—
H	Ashes,	1000	10.00	199	26	211	23.2	3.0	2110	13.7
I	Nitrate of Soda,	160	13.76	320	17	351	37.2	2.0	3510	26.7
	Muriate of Potash,	160								
	Dis. Bone-black,	480								
K	Ammonite,	190	14.23	342	18	374	39.8	2.1	3740	29.4
	Muriate of Potash,	160								
	Dis. Bone-black,	480								
L	Peter Cooper's Bone,	500	13.02	397	18	390	46.2	2.1	3900	35.8
	Nitrate of Soda,	100								
	Muriate of Potash,	160								
M	Nitrate of Soda,	90	13.05	399	18	411	46.4	2.1	4110	36.0
	Ammonite,	80								
	Muriate of Potash,	160								
	S. C. Dis. Rock Phos.,	600								
ooo	Nothing,	—	—	106	53	160	12.3	6.2	1600	—

EXPERIMENTS IN GREEN MANURING.

Two experiments with different kinds of leguminous crops have been started, for the purpose of studying the value of these crops for improving worn out, sandy lands. The crops thus far used have been lupines, cow peas, and crimson clover. Owing to the dry season in 1895 these experiments were not as successful as might be desired, and it is planned to continue the work. Thus far the cow peas have given the best results.

* For description of soil, etc., see Report of this Station for 1894, p. 166.

METEOROLOGICAL OBSERVATIONS.

BY C. S. PHELPS.

The meteorological observations made at the Station during 1895 have been similar to those of past years. The Station equipment consists of the ordinary instruments for obtaining temperature, pressure of the air, humidity, rainfall and snowfall, uniform with those used by voluntary observers for the U. S. Weather Service. In addition to the records made at Storrs, the rainfall for the growing season has been recorded by quite a number of farmers in coöperation with the Station.

The total precipitation for the year (45.7 inches), as measured at Storrs, was nearly up to the average for the State. The average for this State from observers having observations covering ten years or more prior to 1890, is 49.1 inches, and the average at Storrs for the past seven years is 44.7 inches. The precipitation was least during the months of February, May and June. The early part of the growing season was exceptionally dry and the hay and strawberry crops were considerably reduced in yields below an average crop. During the remainder of the growing season, light rainfalls were frequent and most crops were fairly well supplied with moisture. The irregularities in our rainfall are strikingly illustrated by the conditions which existed the past season. The total rainfall at Storrs from May 1st to Sept. 30th was 14.5 inches, while the two months of October and November together, gave 13.7 inches.

The temperature for January was about the average, while February was exceptionally cold. March gave a low average temperature, but April was mild and favorable for farm work. Severe frosts occurred as late as May 14 and 17, doing some damage to early vegetables. The temperature for the summer months was not high. The highest temperature occurred early in June and the third week in September. Light frost occurred on the 15th of September, but the first killing frost came October 15th, thus giving a growing period of 150 days

since the last severe frost in the spring. The average growing season at this Station for the past seven years has been 144 days. The last three months of the year were comparatively mild, but gave an unusually large amount of rainfall.

Through the kindness of the New England Meteorological Society we are able to publish the rainfall records from thirteen of their stations.

Table 30 gives the rainfall as recorded for the six months ending October 31st for twenty-one localities in the State, and table 31 gives the summary of observations made by the Station at Storrs.

TABLE 30.

Rainfall for Growing Season, 1895.

LOCALITY.	OBSERVER.	INCHES PER MONTH.						
		May.	June.	July.	August.	September.	October.	Total.
Falls Village, -	M. H. Dean, - -	2.49	2.77	3.00	2.77	2.24	5.38	18.65
Norwalk, - -	G. C. Comstock, -	1.79	2.10	4.68	4.62	1.99	3.96	19.14
Greenfield Hill, -	Sanford Jennings, -	2.02	1.94	4.62	4.95	2.44	3.58	19.55
Bridgeport, - -	William Jennings, -	1.33	4.37	4.86	7.36	1.69	4.41	24.02
Waterbury, - -	N. J. Welton, - -	1.96	2.82	3.73	7.29	2.16	5.19	23.15
Canton, - -	G. J. Case, - -	1.79	3.53	3.94	6.02	3.13	6.15	24.56
West Simsbury, -	S. T. Stockwell, - -	1.56	3.73	3.68	5.44	2.68	5.66	22.75
Southington, -	Lumen Andrews, -	2.15	3.20	3.20	5.43	3.47	4.05	21.50
New Haven, -	Weather Bureau, -	1.70	2.41	3.77	3.91	2.51	3.20	17.50
Newington, -	J. S. Kirkham, - -	—	2.17	2.12	5.00	2.40	5.32	17.01
Hartford, - -	Prof. S. Hart, - -	2.13	2.10	3.98	—	3.73	5.12	17.06
South Manchester,	K. B. Loomis, - -	1.87	3.57	3.91	5.78	2.42	6.47	24.02
Middletown, -	C. W. Hubbard, - -	2.12	4.23	3.98	4.57	2.39	4.04	21.33
Madison, - -	J. D. Kelsey, - -	2.47	2.44	4.59	4.96	1.88	5.11	21.45
Lake Konomoc, -	New London W. W'ks,	3.01	2.10	6.78	3.02	2.19	4.53	21.63
New London, -	Weather Bureau, -	4.32	2.16	5.83	2.41	1.68	4.71	21.11
Colchester, - -	S. P. Willard, - -	1.89	2.02	4.11	3.63	1.57	6.77	19.99
Lebanon, - -	E. A. Hoxie, - -	2.15	1.90	5.23	2.88	2.87	6.15	21.18
North Franklin, -	C. H. Lathrop, - -	2.75	2.80	5.04	2.76	3.01	5.25	21.61
Storrs, - -	Experiment Station, -	2.16	1.78	4.13	3.48	2.97	6.74	21.26
Voluntown, - -	Rev. C. Dewhurst, -	3.52	3.41	6.37	4.46	1.76	6.14	25.66
Average, - -	- - - - -	**2.26**	**2.74**	**4.36**	**4.54**	**2.44**	**5.14**	**21.63**

TABLE 31.

Meteorological Summary for 1895.

OBSERVATIONS MADE AT STORRS BY THE STATION.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.	Total.
Highest barometer, - - -	30.51	30.49	30.51	30.72	30.43	30.42	30.22	30.28	30.36	30.62	30.64	30.80	30.50	—
Lowest barometer, - - -	29.24	28.61	29.26	29.30	29.65	29.76	29 71	29.69	29.71	29.49	29.23	29.35	29.42	—
Mean barometer, - - -	30.04	29.90	29.97	30.05	30.05	30.08	29.95	29.94	30.04	30.02	30.16	30.12	30.03	—
Highest temperature, - -	47.9	44.8	52.6	80.0	89.0	91.3	87.5	84.0	92.8	65.0	69.2	57.2	71.8	—
Lowest temperature, - -	1.0	-11.5	10.0	27.0	30.0	43.5	45.3	41.8	35.2	19.9	17.7	4.8	21.6	—
Mean temperature, - - -	24.4	19.9	31.1	44.1	57.33	66.65	66.1	68.3	63.1	45.0	41.7	32.63	46.7	—
Relative humidity, - - -	—	—	—	69.2	67.9	76.2	74.9	75.2	76.4	74.9	—	—	—	—
Total precipitation, - - -	5.78	.63	2.62	4.27	2.16	1.78	4.13	3.48	2.97	6.74	6.97	4.12	—	45.65
Number of days with precipitation of .01 inch or more,	14	7	15	12	5	7	9	5	7	6	13	7	—	107
Number of clear days, - -	11	15	11	11	11	11	10	15	12	17	9	11	—	144
Number of fair days, - -	10	6	13	7	15	10	14	12	11	9	11	11	—	129
Number of cloudy days, - -	10	7	7	12	5	9	7	4	7	5	10	9	—	92

[The following is practically a reprint of Bulletin No. 15, of this Station, issued in October, 1895.]

FOOD INVESTIGATIONS.

BY W. O. ATWATER AND CHAS. D. WOODS.

The message of His Excellency Governor Coffin, to the January (1895) Session of the General Assembly of Connecticut, contained the following:

"*Investigations of Food Economy.*—The nutritive values of "different foods, and their proper preparation for the use of "man, is a subject of vital interest to our people. Half the "earnings of the wage-workers of Connecticut—indeed, more "than half the incomes of the bread-winners of Christendom, "are spent and must be spent for their food, and any infor- "mation that enables the laborer to select his food according "to its nutritive value, and to prepare it in the most advan- "tageous manner, must result in much saving of his hard- "earned money, lightening his burdens and increasing the "happiness of his home. The careful, scientific investigation "of the values and uses of food, and making them known to "the people, is one of the purposes of the Experiment Sta- "tions. In this investigation, also, Connecticut takes the "lead. The pioneer work in this line, as in the case of the "Agricultural Experiment Stations, was begun at Wesleyan "University, and has been continued by the Storrs Experi- "ment Station and in coöperation with several scientific "departments of the United States Government. The fruits "have been so valuable that other institutions have followed "the example, and Congress has lately made a special appro- "priation for the distribution of such inquiries throughout "the Union. What has been done in our State has been "accomplished largely by private gifts; but the extent and "importance of the field thus auspiciously entered, call now "for such examination of the facts of the situation as will "determine whether it may have become the duty of the

"State to provide for an early and considerable expansion of "this work within its borders."

In accordance with the above recommendation, the following act was passed:*

AN ACT CONCERNING INVESTIGATION OF FOOD ECONOMY.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. The sum of eighteen hundred dollars annually is hereby appropriated to the Storrs Agricultural College Experiment Station for the purpose of investigating the economy of the food and nutrition of man, and for investigations of the bacteria of milk, butter, and cheese, and their effect in the dairy, and the said sum shall be paid in equal quarterly installments to the treasurer of the Storrs Agricultural College Experiment Station, and the comptroller is hereby directed to draw his order for the same.

SEC. 2. This act shall take effect from its passage.

PURPOSE OF THIS BULLETIN.

Although the publications of the Station have referred to the subject of food economy from time to time, it seems desirable, now that definite arrangements have been made by the State for their prosecution, to explain briefly what has been done, and what it is proposed to do, and how the results of the inquiry may be learned and put into practical use by the people of the State. Such things are slow, at best, in making their way to the homes of the people. The general subject is new, and the public at large are not familiar with it. Some of the popular publications of the Experiment Station, and more especially of the United States Department of Agriculture, have been prepared for the especial purpose of explaining about the chemistry and economy of food and setting forth the results of investigations carried on up to the present time. One purpose of this Bulletin is to call attention to these publications and their contents, and more especially to the Farmers' Bulletin No. 23, on "Foods: Nutritive Value and Cost," and of an article on "Food and Diet," which is reprinted from the Yearbook of the Department of Agriculture for 1894.† Another purpose is to acquaint the people of the State more fully with what the Station is doing

*This appropriation is chiefly for food investigations, but it is also intended to aid the studies which the Station has been making, with the coöperation of Prof. H. W. Conn, of Wesleyan University, on the effects of bacteria in the dairy. These are being prosecuted along the lines which Prof. Conn has followed with such notably useful results.

†See page 128.

in this direction. The authorities of the Station believe that the inquiry is of great importance. They wish to have the results made as immediately and widely useful as possible. The constituency of the Station includes a large number of intelligent and thoughtful people. The Station invites their especial attention to the following statements, and solicits correspondence about this as well as other subjects of its investigations.

HISTORY OF THE INVESTIGATIONS.

In the report of this Station for 1891, pp. 41–171, were briefly set forth some of the results of investigations of the chemistry and economy of foods which had been made by the writers and others associated with them, mostly in the chemical laboratory of Wesleyan University, at different times during a period of then more than twelve and now more than sixteen years.

CHEMICAL ANALYSES OF FISH AND MEATS.

The inquiry had its inception in studies of the chemistry of fish. For these, assistance was provided through Prof. S. F. Baird, in accordance with a usage frequently followed by him as head of the Smithsonian Institution, the United States National Museum, and the United States Fish Commission. Through his agency, small sums were appropriated from time to time, between the years 1877 and 1882, toward defraying the expenses for apparatus and labor of assistants. To the help thus given more was added by private persons, and analyses were made of some two hundred specimens of the flesh of sixty-four species of American marine and fresh-water fishes and invertebrates (oysters, etc.,) commonly used for food.

One of us (W. O. A.) was called upon in 1884 to prepare plans for specimens, labels and other illustrative materials for the Food Collection of the United States National Museum. For this purpose it was desirable, indeed logically necessary, to illustrate the fundamental principles of food economy. To this end, information regarding the chemical composition of our common food materials was indispensable. An adequate series of investigations of American food

products would be a very large undertaking. Its necessity was not understood. The only thing to do was to make a beginning, and trust that, as the results should appear, help for further inquiry would be found. Accordingly, not far from one hundred specimens of meat and other animal food materials were analyzed in the chemical laboratory of Wesleyan University before the establishment of the Station, the expense being borne in part by the National Museum and in part by contributions from private sources. The results of these investigations, taken in connection with some studies of dietaries which followed, implied that our meats contain much more fat than the needs of the consumer for nutrition call for, or the demands of home or foreign markets warrant; that, in other words, there is a serious error in the present method of meat production, which is so important a factor of agriculture in the United States. To get more light upon this subject another series of analyses were made as a part of the chemical work of the Experiment Station. Finally, as a part of a study of dietaries carried out in connection with the United States Department of Labor, a third series of analyses were performed. The results were all given, in the chapter on "The Composition of Food Materials," in the Report of this Station for 1891, pp. 46–90, and were used in the summarized table in that Report.

The table thus prepared has served as a "standard table" of composition of American food materials up to the present time. A standard table is now in preparation for the U. S. Department of Agriculture, which will include the results of over three thousand* analyses of American food products, more than two-thirds of which have been made since the above Report was printed. We have thus to-day a reasonably clear idea of the chemical composition and nutritive values of the food commonly in use in the United States.

STUDIES OF DIETARIES.

In 1886 Col. Carroll D. Wright, then Commissioner of Labor of the State of Massachusetts and since United States Commissioner of Labor, undertook some investigations of the

* These do not include specimens of milk, butter, sugar, condiments, beverages, etc., of which a large number of specimens have been analyzed. Of the analyses included in the compilation referred to, not far from one-third were made in the chemical laboratory of Wesleyan University, in connection with the work of the Station and otherwise.

statistics of the food consumption of the families of laboring classes in Massachusetts and Canada. The data thus obtained as to kinds and amounts of foods consumed were sent to Middletown, and from the analyses above referred to, the quantities of nutritive ingredients in fifteen dietaries of as many families and boarding-houses were estimated. The results were published in the Report of the Massachusetts Bureau of Labor for 1886. With this exception the food investigations up to 1890 had been chiefly along the lines of the chemical composition of American food materials. In 1890 a series of accurate studies of dietaries were undertaken by the Station in coöperation with the U. S. Department of Labor, and up to January, 1895, twenty-one such studies of the food consumption of families of mechanics and men in professional life had been carried out. The main results were given in the Reports of the Station for the year 1891 to 1894 inclusive. They are to be given in more detail, with accounts of other work in this direction, in a publication of the U. S. Department of Labor.

ANALYSES OF FOOD MATERIALS EXHIBITED AT THE WORLD'S FAIR.

In connection with the studies of dietaries, a considerable number of food materials have been analyzed. The principal work in this direction since 1890, however, has been in the analyses of foods exhibited at the World's Fair.

As a member of the Jury of Awards at the Fair one of us (W. O. A.) was requested by the Executive Committee on Awards to take charge of an examination of some of the more interesting and important food materials there exhibited. This investigation was made in accordance with the purpose of the World's Columbian Commission, which was to make the Fair educational and to provide that its influence should continue after the Fair itself should end. Probably no other occasion has offered such an opportunity for comparison of materials used for the nutrition of man. Certainly none has been so favorable for collecting specimens of food materials, including especially the animal foods, which are most interesting to us in the United States. Part of the analyses were, with the coöperation of the Station, carried out at Chicago during the Fair.

At the close of the latter the work was transferred to Middletown, where it has been completed with the aid of the Station and of Wesleyan University. Some five hundred specimens have been analyzed, and the investigation thus made is more extensive than any similar one yet undertaken.

The results of these analyses will be incorporated in the standard table above referred to as being now in preparation.

INVESTIGATIONS WITH THE BOMB CALORIMETER.

The study of food and nutrition has shown the need of learning the fuel-values of food materials, or in other words, the amounts of potential energy which they contain and which may be changed to heat or muscular power or other form of energy in the body. The apparatus for this purpose is called the calorimeter. Investigations with a form of calorimeter were described in the Report for 1890. A form which has proven more satisfactory is the so-called bomb calorimeter. Hitherto the only satisfactory bomb calorimeter has been that devised by Prof. Berthelot in Paris, but its great cost; $1,000 or more, which is due to the large quantity of platinum required for its construction, has prevented its general use. With the aid of Prof. Hempel, of Dresden, we succeeded in obtaining a bomb calorimeter which cost about $200, and has proved quite satisfactory. This apparatus and the attempt to develop it into a form which, without sacrifice of accuracy and reliability, will be durable, convenient and made at a cost which will bring it within the reach of ordinary laboratories, are described in the Report of this Station for 1894. The efforts in this direction are being materially aided by the U. S. Department of Agriculture. Although some details of construction and manipulation still need to be worked out and tested, the results are already highly satisfactory.

RESPIRATION CALORIMETER.

Research upon nutrition has reached the point where the study of the application of the laws of the conservation of matter and of energy in the living organism are essential. That is to say, we must be able to determine the balance of income and outgo of the body, and this balance must be expressed both in terms of matter and of energy. For this purpose a

respiration calorimeter is being elaborated. This is an apparatus in which an animal or a man may be placed for a number of hours or days, and the amounts and composition of the food and drink and inhaled air; the amounts and composition of the excreta, solid, liquid and gaseous; the potential energy of the materials taken into the body and given off from it; the quantity of heat radiated from the body; and the mechanical equivalent of the muscular work done, are all to be measured. The experimenting is complicated, costly and time-consuming. The results already obtained are, however, very encouraging in their promise of future success.

PUBLIC AND PRIVATE AID TO THE INVESTIGATIONS.

For an institution with an annual income of only $7,500 per year, which up to July of this year has been the whole amount received by the Storrs Station from public sources, so large an investigation of foods might seem inexcusable. The justification is found in two facts. One is that the several lines of investigation upon the food and nutrition of man are more or less nearly parallel with those upon the nutrition of animals, which the Station is also prosecuting, and the two are so conducted as to really form one department of inquiry. The other is, that a considerable part of the work is done with little or no expense to the Station treasury. Free use is had of the rooms and apparatus in the chemical laboratory of Wesleyan University, whose trustees are desirous of promoting scientific research, especially that of the more abstract kind to which an already large and gradually increasing part of the investigation belongs. The calorimetric investigations especially are of this order. The studies of dietaries were made in coöperation with the U. S. Department of Labor, which bore a large part of the expense. The cost of the investigations of food exhibited at the World's Fair was borne mainly by the Bureau of Awards of the Columbian Commission. Considerable sums have been given from time to time by private individuals in aid of different parts of the more purely scientific inquiry.

It would be unjust to close even so brief an account of the development of these researches without more specific acknowledgment of the generosity of the contributors to the

expenses of the earlier work. Among these have been Mr. A. R. Crittenden, Mr. Henry G. Hubbard, Miss Margaret S. Hubbard, Mr. I. E. Palmer, Mr. E. K. Hubbard, and the late Hon. J. W. Alsop, M. D., of Middletown; Mr. George L. Roberts, of Boston; and Mr. E. K. Blackford, Mr. Mark Hoyt, and notably Mr. F. K. Thurber, of New York. The most generous of these benefactors was Dr. Alsop, a large part of whose donations were made in the early period of the investigations at Middletown. It will certainly be a satisfaction to the large number of the friends of our honored and lamented fellow-citizen to know, what has been known to only a few of them, that his characteristic generosity made possible the beginnings of a scientific investigation which has since come to receive both State and National recognition and support, and has grown to be the most extensive as well as the most thorough inquiry of the sort ever undertaken in this country or in Europe.

FOOD INVESTIGATIONS BY THE UNITED STATES DEPARTMENT OF AGRICULTURE.

The relation of the Station to this work, especially through its Director, is stated by the Director of the Office of Experiment Stations in the letter of transmittal of Bulletin No. 21 of that office,* from which the following is cited:

"Investigations of the hygienic and pecuniary economy of food are of comparatively recent date. It is scarcely fifty years since the classical researches of Liebig began to pave the way for finding practically all we know to-day of the ingredients of our food materials, the ways in which they are used in the body, and the kinds and combinations which are best adapted to health and purse. The first at all extensive series of investigations of materials used as the food of man, undertaken in the United States, were studies of the chemistry of fish, prosecuted under the auspices of the United States Fish Commission in the chemical laboratory of Wesleyan University, by Professor Atwater in the years 1878–1881.

"A large part of the work thus far done in the United States has been at private expense. But, as often happens, the inquiries thus benevolently begun have proven so useful that public funds are becoming available for their prosecution. On the recommendation of the Secretary of Agriculture, the sum of $10,000 was included in the appropriation for the Department of Agriculture for the fiscal year ending June 30, 1895, the purpose of which was to enable him to investigate and report upon the food economy of the people of the

*"Methods and Results of Investigations of the Chemistry and Economy of Food," W. O. Atwater, Department of Agriculture, 1895, pp. 222.

United States. The supervision of the investigations thus provided for, has been assigned to the Office of Experiment Stations, and Professor Atwater has been appointed special agent in charge."

The appropriation for the investigation upon foods referred to above was for the fiscal year ending June 30, 1896, increased by Congress to $15,000. The work is distributed in different parts of the country. All of the food investigations of the Station are being conducted in coöperation with the Department of Agriculture, by which a considerable share of the expense is paid. By such coöperation a much larger amount of research is being carried on by the Station than the State appropriation provides for, and at the same time the contribution by this State to the enterprise is made much more fully available to the country at large.

THE NEED FOR FOOD INVESTIGATIONS.

The need of effort to improve the food economy of the laboring classes, and especially that of people with very small incomes, is greater than appears on the surface. Statistics show that half or more than half of the earnings of wage-workers in general is expended for food, and that as the income is diminished the proportion which must be used for food is increased. Not only does food make the chief item of expenditure, but people know less of the ratio of the nutritive value of their food to its cost than they do of the relation between cost and real value of any other of the prime necessities of life. It is easy for a man to judge whether the price of rent of a tenement is reasonable, for the advantages and disadvantages are plainly seen. It is easy to tell whether a coat is worth its cost, for the eye judges its appearance and experience tells how the cloth will wear. Regarding the economy of food, however, very few people have any clear idea. Even the most intelligent have little notion of the kinds and amounts of actual nutriment in the different kinds of food they buy. They know very little as to the combinations which are best fitted for their nourishment, and have still less information as to the ratio between value and cost. Three things, however, are reasonably certain:

First—Improvement is possible. Better kinds and combinations of food are within reach of the people. Wiser selection, more economical buying and better cooking are feasible.

Second—The best thing to do for the people is to show them that they can improve, explain the advantage and teach them how to do it. The work will be slow. Doubtless the surest method is teaching the young. But it is possible to do a great deal.

Third—The way to go about it is to find out, first of all, how the people actually live, what are their actual dietary practices, in what details improvement is most feasible, and how the improvements may best be introduced.

For the latter are needed not only studies in the home and the ordinary analyses in the laboratory, but a large amount of abstract research which will reveal more clearly the fundamental laws of nutrition.

LINES ALONG WHICH INVESTIGATIONS NEED TO BE MADE.

The field is new and there is much to be done. It would be far beyond the purpose of this Bulletin to attempt to outline all that needs to be undertaken. Among the more important questions to be studied are the following:

Calorimetry.—Considerable work has been done with the bomb and respiration calorimeters, as already stated. This is really the most important investigation the Station is undertaking. It belongs to the higher realm of scientific research. Like other abstract inquiries it is the necessary foundation of the most useful knowledge. A large amount of such research has been and will continue to be carried on by the Station.

Digestibility of Food.—Very few accurate experiments upon the digestibility of the food by man have been made and, with the exception of a small number in this laboratory, none have been carried on in this country so far as the writers are aware.

The Preparation of Food for Use. Cooking.—This is a subject of great importance. It includes both the commercial preparation of food by the manufacturer and the preparation in the household. The actual practice of cooking in different households, the effects of cooking upon digestibility and nutritive value, and the ways for improvement, are themes of especial interest. The field of inquiry is large. Very little has been done in it. Scientific investigation of the highest order is needed.

Food Supply.—Answers are here sought to the questions: What does a given region or market furnish, *i. e.*, what are the principal food materials available to the purchaser? What does each cost? How much nutriment does each contain? What ones are the most economical? The real purpose is to compare the nutritive values of foods with their cost as they are actually offered to consumers in different parts of the country, and to learn what one's people who wish to economize can best afford to buy and use. These questions must be studied by actual examination of the market supplies in different places.

Food Consumption. Dietary Studies.—The inquiries on the subject seek answers to the questions: What kinds and quantities of materials do people actually buy and eat, and how economical or uneconomical are they in the purchase of their food? The real subject here is the actual eating habits of the people. The data are obtained in part by inquiries in different markets, but the most valuable information comes from studies of actual dietaries of typical people of different classes. The inquiries are made by weighing, measuring and analyzing the food actually purchased, eaten, and left unconsumed.

ERRORS IN FOOD ECONOMY.

Most of the dietary studies thus far made by the Station have been those of families and boarding-houses in cities, though a few studies have been made with farmers' families. The results are not yet sufficient for the most reliable conclusions. But the scientific research thus carried out and used in interpreting the observations of practical life implies that several errors are common in the use of food:

First, many people purchase needlessly expensive kinds of food, doing this under the false impression that there is some peculiar virtue in the costlier materials, and that economy in our diet is somehow detrimental to our dignity or our welfare. And, unfortunately, those who are most extravagant in this respect are often the ones who can least afford it.

Secondly, the food which we eat does not always contain the proper proportions of the different kinds of nutritive ingredients. We consume relatively too much of the fuel ingredients

of food, such as the fats of meats and butter, sugar and sweetmeats, and starch which makes up the larger part of the nutritive material of flour and potatoes. Conversely, we have relatively too little of the protein or flesh-forming substances, like the lean of meat and fish and the gluten of wheat, which make muscle and sinew and which are the basis of blood, bone and brain.

Thirdly, many people, not only the well-to-do, but those in moderate circumstances, use needless quantities of food. Part of the excess, however, is simply thrown away with the wastes of the table and the kitchen; so that the injury to health, great as it may be, is doubtless much less than if all were eaten. Probably the worst sufferers from this evil are well-to-do people of sedentary occupations—brain-workers as distinguished from hand-workers.

Finally, we are guilty of serious errors in our cooking. We waste a great deal of fuel in the preparation of our food, and even then a great deal of the food is very badly cooked. A reform in the methods of cooking is one of the economic demands of our time.

The following is from the article on Food and Diet in the Yearbook of the United States Department of Agriculture referred to beyond:

"Just where, and among what classes of people this waste of food is worst, it is not possible to say, but there is certainly a great deal more of it in the United States than in Europe. There may be more in boarding-houses than in private families, and still more in hotels and restaurants. The worst sufferers from it are, doubtless, the poor, but the large body of people of moderate means, the intelligent and fairly well-to-do wage-workers, are guilty of similar errors in this regard.

"Sometimes this bad economy is due to ignorance. The School of Sociology in Hartford in coöperation with the Storrs Experiment Station, is undertaking some inquiries into the food supply in that city. The first family visited was that of an Irish coal laborer, who earns $8 a week when he has full work. The week the inquiry was begun he earned a little over $6; the week before he had only work enough to bring $2.50. The family consists of himself, wife and five children. The day on which the inquiry began they spent 35 cents for bread. Service as a cook in a well-to-do family before she was married had shown the mother how to make good bread. She had plenty of spare time to make it at home, and 13 cents would have paid for the flour, yeast and other materials, including the extra coal needed to make the day's supply, which she had bought of the baker. She had not thought so far as to see that she might thus have easily saved 23 cents a day in that item alone. She was, however, wise enough

not to get the highest-priced meats, and she did try in various ways to economize as best she knew how. But, nevertheless, she bought eggs at 25 cents a dozen, not realizing that they were for her a very dear food. The result of the examination of the dietary showed it to supply just about four-fifths as much nutriment as the American standard would require for people at moderate muscular work. By wiser management the family might have had the full amount at considerably less cost.

"One fruitful source of this bad economy is the prejudice against the cheaper kinds of food, and the impression that the finer and costlier kinds have some special virtue. With this is a false pride which considers economy in food a thing unworthy of the buyer's dignity. A series of investigations lately begun in New York City* have brought out some striking illustrations of this unfortunate fact. Among the families visited is one of seven persons, so poor that the mother has not a dress in which she is willing to be seen on the street of even the poor quarter where she lives. She therefore stays in the house day after day, giving herself up to constant drudgery. The cost of food for the family is $14 per week, or $2 per person. The markets of New York, including those of this district, afford excellent food at extremely low prices, so that the family might be well nourished at half the expense. But these people, some of whom really wish to economize, are the victims of a theory. They think they must have 'the best.' They buy the nicest and costliest cuts of beef, the tenderest chicken, the earliest spring vegetables, and other things in like manner, and pay high prices for them. They will doubtless continue to do so until they learn that their policy is an unwise one, and why it is unwise."

As regards the food of people in business and professional life the most common error from the standpoint of health is that of an excessive and illy-balanced diet. A great many people with little muscular exercise eat too much. The diet is apt to consist largely of the materials which contain fat, starch and sugar.

The dietaries of the farmers' families thus far studied were out of balance. The food contained relatively too little of the protein compounds, those which make muscle, blood and bone, and relatively too much of the fuel ingredients, especially starch. In other words, they would have been improved by the use of more of the leaner kinds of meats, as beef and veal, more fish, milk, beans and peas, and less of such materials as potatoes, corn meal and sugar. There was not such variety of food as the farm and garden might easily

*These inquiries are being carried out by coöperation between the U. S. Department of Agriculture and the New York Society for the Improvement of the Condition of the Poor under the immediate direction of one of the writers (C. D. W.) They are made among families in the most congested parts of that city. Hand in hand with the investigation goes the practical application by the teaching of food economy in cooking schools and otherwise. This enterprise, and a somewhat similar one which is being carried out in Chicago by coöperation between the Department of Agriculture and the Hull House, are among the most interesting and useful of the kind with which the writers are familiar.

supply. It may be that these cases do not fairly represent the ordinary farmer's diet. A large number of investigations must be made before general conclusions will be warranted.

The best farmers in the State are carefully considering the kinds and amounts of plant foods in their soils and fertilizers and the composition of different feeding stuffs, and the quantities necessary to make complete and well-balanced rations for their cows and other animals of the farm. Is it not worth while to consider carefully the nutrition of themselves and their families as well as that of their crops and their live stock?

The products of the farm are for the use of man. A large part are directly or indirectly for his food. This food is for the sustenance of the community at large. People consider carefully the quality and value of their clothing, their dwellings, and the thousand and one things which are needed for their daily welfare; but their food, the cost of which makes up the large share of the cost of living of the great majority, and which has so much to do with the health and strength of every one, is a subject of which they have extremely little definite knowledge. Is it not time that more attention should be given to it?

The Experiment Stations of the country have hitherto studied the soil, the plant and the animal. By the recent act of Congress they are called upon to also study the nutrition of man. The early work of this Station in this direction had to be sustained from sources outside of the Government appropriation for its support. Its resources for the purpose were extremely limited. Now that its means are increased, it is endeavoring to increase its usefulness in this direction.

FOOD PUBLICATIONS.

The results of the investigations referred to above have been, and are being published by the Station and also by the Office of Experiment Stations of the U. S. Department of Agriculture. Lists of the publications thus far issued are appended herewith.

Articles on Food Investigations by the Station.

Title.	Publication.	Pages.
Chemistry and Economy of Foods,	Bulletin No. 7, 1891,	16
The Composition of Food Materials,	Report for 1891,	50
Studies of Dietaries,	Report for 1891,	16
Dietaries and Dietary Standards,	Report for 1891,	55
Methods of Food Investigation,	Report for 1891,	10
Studies of Dietaries,	Report for 1892,	28
Economy of Food,	Report for 1892,	28
Studies of Dietaries,	Report for 1893,	24
Studies of Dietaries,	Report for 1894,	31

Publications of the Office of Experiment Stations of the U. S. Department of Agriculture on the Food and Nutrition of Man.

Methods and Results of Investigations on the Chemistry and Economy of Foods, by W. O. Atwater, Bulletin No. 21 of the Office of Experiment Stations. 222 pages.

Foods: Nutritive Value and Cost, by W. O. Atwater. Farmers' Bulletin No. 23. 32 pages.

Meats: Composition and Cooking, by Chas. D. Woods. Farmers' Bulletin No. 34. 30 pages.

Food and Diet, by W. O. Atwater. A reprint of an article in the Yearbook of the Department for 1894. 43 pages.

The Station invites the attention of the people of the State to the above publications, and especially to the paper on "Food and Diet," reprinted from the Yearbook of the U. S. Department of Agriculture for 1894. This, with Farmers' Bulletin No. 23, on "Foods: Nutritive Value and Cost," epitomizes the more practical results of the investigations thus far published by the Station, together with more or less of the outcome of European enquiries, and will serve as an introduction to future publications by the Station.

The Department of Agriculture has furnished this Station with a considerable number of reprints of the article on "Food and Diet," for distribution in Connecticut. They will be mailed free of cost to citizens of the State who apply for them until the supply is exhausted. Applications for it, as for the publications of the Station should be made to the Station at Storrs, as explained on page 2 and the last page of the cover of this report. Publications of the Department of Agriculture are obtained through members of Congress, and by application to the Secretary of Agriculture, Washington, D. C.

STUDIES OF DIETARIES.

REPORTED BY W. O. ATWATER AND CHAS. D. WOODS.

Accounts of studies of dietaries of families and a boarding house, by the Station, have been given in previous reports as follows:

1. A boarding house.*
2. A chemist's family.*
3. A jeweler's family.†
4. A blacksmith's family.†
5. A machinist's family.†
6. A mason's family.†
7. A carpenter's family.†
8. A carpenter's family.†
9. The family of the Station Agriculturist in winter.‡
10. A mason's family (the same as No. 6).‡
11. A carpenter's family (the same as No. 8).‡
12. A College students' club.‡
13. The family of the Station Agriculturist in summer.‡
14. A widow's family.‖
15. A Swede family.‖
16. A College club.‖
17. A Divinity School club.‖
18. A College lady students' club.‖
19. A Swede family (same as No. 15).‖
20. Three chemists.‖
21. A carpenter's family.‖

Eleven additional dietaries are here reported:

25. An infant nine months old.
26. A chemist's family.
27. A farmer's family.
28. A chemist's family (as 26).
29. A chemist's family (as 26).
45. A farmer's family.
46. A farmer's family (as 45).
120. A farmer's family.
121. A farmer's family.
123. A farmer's family.
124. A College students' eating club.

Dietary studies 25, 26, 28 and 29 were conducted for the Station by Mr. A. P. Bryant; 27 by Mr. A. W. Smith; 123 by Mr. C. B. Lane; 124 by Prof. C. S. Phelps and Miss H. L. Smith, Professor of Domestic Science in Storrs College; and 45, 46, 120 and 121 by Prof. John L. Bridge, of the Connecticut Literary Institute, Suffield, Conn. The chemical analyses were, for the most part, made by Mr. H. M. Burr and Mr. H. A. Torrey. Prof. Bridge assisted in the analyses of some of the food materials used in dietaries 45 and 46.

The general plan of the investigation included an account of the amounts and composition of all food materials of nutritive value in the house at the beginning, purchased during

* Report of this Station, 1891, pp. 90–106. † Report of this Station, 1892, pp. 135–162.
‡ Report of this Station, 1893, pp. 174–197. ‖ Report of this Station, 1894, pp. 174–204.

and remaining at the end of the experiment, and of all the kitchen and table wastes. The amounts of different food materials on hand at the beginning and received during the experiment were added; from this sum the amounts remaining at the end were subtracted. This gave the amount of each material actually used. From the amount thus obtained and the composition of each material, as shown by analysis, the amounts of the nutritive ingredients were estimated. From these were subtracted the amounts of nutrients in the waste, and thus the amounts of the nutrients actually eaten were learned.

Account was kept of the meals taken by the different members of the family, and by visitors. The number of meals for one man, to which the total number of actual meals taken was equivalent, was estimated upon the basis of the potential energy, as has been done in previous investigations here. These energy equivalents, which are stated below, are somewhat arbitrary, and require revision in the light of accumulating inquiry. It has seemed best, however, to use the same figures here as in the previous reports and postpone the change until these dietaries may be summarized with others in a later publication.

Estimated Relative Quantities of Potential Energy in Nutrients Required by Persons of Different Classes.

Man at moderate work,	10
Woman at moderate work,	8
Child, 15 years to 6 years old,	7
Child, 6 years to 2 years old,	5
Child, under 2 years old,	2½

EXPLANATION OF TABLES.

The figures in the first table of each dietary, giving the actual amounts of food and of nutrients in the food used during the dietary, are based upon the weights of the food materials as they were purchased and used; that is, they include bone and other refuse, except where specified.

The first three columns in the table contain the percentages of protein, fat and carbohydrates used in computing the amounts of those nutrients in the different food materials. In all cases where the composition was not fairly well known from the previous analyses, specimens of the food materials

actually used in the dietary, or specimens as nearly identical as possible, were analyzed. The cases in which special analyses were made in connection with these dietaries are indicated in the table by the letter *a*, following the name of the material. The weights of the dried (water-free) table and kitchen wastes, and their composition, are given in the last line of the table. Exactly what is included in these wastes is explained in the foot note on page 97 of the Report of this Station for 1891.*

The second table of each dietary gives the summary of the food materials and nutrients used in the dietary, the quantities estimated per man per day, and the percentages of food materials of different classes, and of nutrients furnished by each class. The quantities per man per day were found by dividing the weights of the different food materials and nutrients used in the dietary by the number of days for one man to which the total meals taken were equivalent.

The last table in each dietary gives the nutrients and potential energy in food purchased, in table and kitchen wastes, and in the portion actually eaten. The estimates of animal and vegetable nutrients in the waste are computed as described below. In estimating the fuel values of the nutritive ingredients the protein and carbohydrates are assumed to contain 4.1, and the fats 9.3 calories of potential energy per gram.†

It was not practicable in the collection of the wastes to distinguish between that which came from animal and that from vegetable food. It is, however, possible to estimate with more or less accuracy how much of the nutritive materials came from the animal and how much from the vegetable foods. As there were practically no carbohydrates in any of the animal foods except milk and cheese, and but little in these, we shall not greatly err in assuming that all the waste carbohydrates came from the vegetable foods. It will also be fairly accurate to assume that there are the same proportions of protein, fat and carbohydrates in the vegetable waste as in the

* The words refuse and waste are used somewhat indiscriminately. In general, refuse in animal food represents inedible material, although bone, tendon, etc., which are classed as refuse, may be utilized for soup. The refuse of vegetable foods, such as parings, seeds, etc., represent not only inedible material, but also more or less of edible material. The waste includes the edible portion of the food, as pieces of meat, bread, etc., which might be saved, but is actually thrown away with the refuse.

† Report of this Station, 1890, p. 174.

whole vegetable food purchased. In other words, the amount of vegetable protein and vegetable fat in the waste will bear nearly the same ratio to the total amount of vegetable protein and fat in the food purchased that the carbohydrates of the waste does to the total carbohydrates of the vegetable food. Taking the percentages of the weights of the carbohydrates in the total waste as the measure of the protein and fats in the vegetable wastes, the actual weights of protein and fat in the latter are readily calculated. Subtracting these weights of vegetable protein and fat from the total weight of these ingredients in the waste, the remainders give the amounts of animal protein and fats in the whole waste.

Table 63 summarizes the results of the thirty-two dietary studies which have been made by the Station.

No. 25. DIETARY OF AN INFANT.

Two studies of the dietary of an infant nine months old. The first study began February 5, 1895, and continued eight days. The second began March 5 and continued nine days.

TABLE 32.

Food Materials in Dietary of an Infant.

Food Materials.	Percentage Composition.			Total Cost.	Weight Used.			
					Total Food Material.	Nutrients.		
	Protein.	Fat.	Carbohydrates.			Protein.	Fat.	Carbohydrates.
First Study.	%	%	%	$	Grams.	Grams.	Grams.	Grams.
Milk *(a)*, - -	4.38	5.43	4.00	.64	9,755	427	530	390
Second Study.								
Milk *(a)*, - -	3.94	4.47	4.62	.67	10,120	399	452	468
Oatmeal gruel *(a)*, -	.87	.18	2.94	.02	2,720	24	5	80
Sugar, - - -	—	—	100.00	.01	100	—	—	100
Total, - - -	—	—	—	—	12,940	423	457	648
For Infant One Day.					Protein.	Fat.	Cbhy.	Cal.
First study, - -	—	—	—	.08	53.4	66.3	48.7	1,035
Second study, - -	—	—	—	.08	52.9	57.1	81.0	1,080

No. 26. DIETARY OF A CHEMIST'S FAMILY.

The study began November 7, 1894, and continued 28 days. The members of the family and number of meals taken were as follows:

Man, 26 years old,	85 meals.
Woman, 25 years old (85 x .8), equivalent to	68 meals.
Servant girl, 13 years old (80 x .6), equivalent to	48 meals.
Man (college student*), 20 years old,	15 meals.
Total number of meals taken equivalent to	216 meals.

Equivalent to one man 72 days.

TABLE 33.

Food Materials and Table and Kitchen Wastes in Dietary of a Chemist's Family.

Food Materials.	Percentage Composition.			Total Cost.	Weight Used.			
					Total Food Material.	Nutrients.		
	Protein.	Fat.	Carbohydrates.			Protein.	Fat.	Carbohydrates.
Animal Food.	%	%	%	$	Grams.	Grams.	Grams.	Grams
Beef.								
Neck,	13.9	11.9	—	.81	5,215	725	621	—
Round,	18.1	12.6	—	.59	2,240	405	282	—
Shoulder clod,	19.3	11.3	—	.37	1,675	323	189	—
Sirloin,	15.9	17.6	—	.46	1,315	209	231	—
Hind shank,	9.1	5.3	—	.19	1,760	160	93	—
Liver,	21.6	5.4	1.8	.12	905	195	49	16
Flank, corned,	12.4	29.2	—	.40	1,815	225	530	—
Corned, canned,	28.5	14.0	—	.22	995	284	139	—
Total,	—	—	—	3.16	15,920	2,526	2,134	16
Mutton.								
Shoulder,	13.5	15.6	—	.41	1,145	154	179	—
Pork.								
Chops,	14.1	25.6	—	.52	1,985	280	508	—
Ham,	13.3	33.4	—	.16	400	53	134	—
Lard,	—	100.0	—	.40	180	—	180	—
Total,	—	—	—	1.08	2,565	333	822	—
Fish, Etc.								
Cod, salt, boned,	22.2	.3	—	.30	1,530	340	4	—
Oysters, "solids,"	6.1	1.4	3.3	1.04	2,355	144	33	78
Total,	—	—	—	1.34	3,885	484	37	78
Eggs,	13.1	9.5	—	.57	995	130	95	—
Butter,	—	82.4	—	2.75	3,670	—	3,024	—
Cheese,	26.0	34.2	2.3	.39	950	247	325	22
Milk,	3.3	4.0	5.0	1.85	27,895	920	1,116	1,395
Mince meat preparation	6.7	1.4	60.2	.10	225	15	3	136
Total,	—	—	—	11.65	57,250	4,809	7,735	1,647

* Took dinner with the family four times a week.

TABLE 33.—*(Continued.)*

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			TOTAL COST.	WEIGHT USED.			
						NUTRIENTS.		
	Protein.	Fat.	Carbohydrates.	Total Cost.	Total Food Material.	Protein.	Fat.	Carbohydrates.
VEGETABLE FOOD.	%	%	%	$	Grams.	Grams.	Grams.	Grams.
Cereals, Sugar, Etc.								
Flour, wheat,	11.3	1.1	74.6	.58	10,430	1,178	115	7,781
Oat meal,	15.6	7.3	68.0	.18	1,650	257	120	1,122
Rice,	7.8	.4	79.0	.01	75	6	—	59
Bread,	9.5	1.2	52.8	.04	455	43	6	240
Cookies,	6.8	8.9	75.3	.07	225	15	20	169
Crackers, graham,	9.8	13.6	69.7	.07	225	22	30	157
Crackers, milk,	9.3	13.1	69.2	.23	1,160	108	152	803
Crackers, oyster,	11.0	8.8	74.2	.34	1,700	187	150	1,261
Starch, etc.,	—	—	98.0	.05	215	—	—	211
Sugar,	—	—	100.0	.48	4,370	—	—	4,370
Molasses & maple syrup,	—	—	70.0	.13	810	—	—	567
Cocoa,	21.6	28.9	37.7	.01	20	4	6	7
Total,	—	—	—	2.19	21,335	1,820	599	16,747
Vegetables.								
Onions,	1.5	.4	8.9	.27	4,535	68	18	404
Potatoes (15 % refuse),	2.1	.1	18.0	.54	16,540	347	17	2,977
Sweet potatoes (12½ % refuse),	1.8	.7	27.1	.34	9,325	168	65	2,527
Total,	—	—	—	1.15	30,400	583	100	5,908
Fruits, Nuts, Etc.								
Apples,	.4	.4	12.4	.52	15,765	63	63	1,955
Dates,	1.9	4.5	61.9	.08	455	9	20	282
Grapes,	1.0	1.3	13.3	.31	2,835	28	37	377
Oranges, pulp,	.8	.6	9.7	.59	1,560	13	9	151
Prunes, dried,	2.0	.7	58.6	.20	905	18	6	531
Peanuts,	17.3	25.9	16.3	.27	820	142	212	134
Total,	—	—	—	1.97	22,340	273	347	3,430
Total vegetable food,	—	—	—	5.31	74,075	2,676	1,046	26,085
Total food,	—	—	—	16.96	131,325	7,485	8,781	27,732
Waste—Table and Kitchen.								
Cooked meat,	27.9	11.0	—	.02	85	24	9	—
Fat meat and gristle,*	1.0	90.0	—	.12	1,815	18	1,634	—
Cheese, rind,	26.0	34.2	2.3	.08	225	59	77	5
Bread,	9.5	1.2	52.8	.02	175	17	2	92
Flour,	11.3	1.1	74.6	.01	225	25	3	168
Potatoes,	2.1	.1	18.0	.02	1,135	24	1	204
Total,	—	—	—	.27	3,660	167	1,726	469

* Composition and cost estimated.

TABLE 34.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of a Chemist's Family.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.				
	Food Material.	Nutrients.			Food Material.	Nutrients.			Cost.
		Protein.	Fat.	Carbo-hydrates.		Protein.	Fat.	Carbo-hydrates.	
For Family, 28 Days.	Grams.	Grams	Grams	Grams.	Lbs.	Lbs.	Lbs.	Lbs.	$
Beef, veal and mutton,	17,065	2,680	2,313	16	37.6	5.9	5.1	—	3.57
Pork, lard, etc., -	2,565	333	822	—	5.6	.7	1.8	—	1.08
Fish, etc., - -	3,885	484	37	78	8.6	1.1	.1	.2	1.34
Eggs, - - -	995	130	95	—	2.2	.3	.2	—	.57
Butter, - - -	3,670	—	3,024	—	8.1	—	6.7	—	2.75
Cheese, - - -	950	247	325	22	2.1	.6	.7	—	.39
Milk, - - -	27,895	920	1,116	1,395	61.5	2.0	2.5	3.1	1.85
Mince meat, - -	225	15	3	136	.5	—	—	.3	.10
Total animal food, -	57,250	4,809	7,735	1,647	126.2	10.6	17.1	3.6	11.65
Cereals, sugar, starch,	21,335	1,820	599	16,747	47.0	4.0	1.3	36.9	2.19
Vegetables, - -	30,400	583	100	5,908	67.0	1.3	.2	13.0	1.15
Fruits, - - -	22,340	273	347	3,430	49.3	.6	.8	7.6	1.97
Total vegetable food,	74,075	2,676	1,046	26,085	163.3	5.9	2.3	57.5	5.31
Total food, - -	131,325	7,485	8,781	27,732	289.5	16.5	19.4	61.1	16.96
Per Man per Day.									
Beef, veal and mutton,	237	37	32	—	.52	.08	.07	—	—
Pork, lard, etc., -	36	5	11	—	.08	.01	.03	—	—
Fish, etc., - -	54	7	1	1	.12	.02	—	—	—
Eggs, - - -	14	2	1	—	.03	—	—	—	—
Butter, - - -	51	—	42	—	.11	—	.09	—	—
Cheese, - - -	13	3	4	—	.03	.01	.01	—	—
Milk, - - -	387	13	16	20	.85	.03	.04	.04	—
Mince meat, - -	3	—	—	2	.01	—	—	.01	—
Total animal food, -	795	67	107	23	1.75	.15	.24	.05	.16
Cereals, sugar, starch,	297	25	8	232	.65	.05	.02	.51	—
Vegetables, - -	422	8	2	82	.93	.02	—	.18	—
Fruits, - - -	310	4	5	48	.68	.01	.01	.11	—
Total vegetable food,	1,029	37	15	362	2.26	.08	.03	.80	.08
Total food, - -	1,824	104	122	385	4.01	.23	.27	.85	.24
Percentages Total Food.	%	%	%	%					%
Beef, veal and mutton,	13.0	35.8	26.4	—	—	—	—	—	21.1
Pork, lard, etc., -	2.0	4.4	9.4	—	—	—	—	—	6.4
Fish, etc., - -	3.0	6.5	.4	.3	—	—	—	—	7.9
Eggs, - - -	.7	1.7	1.1	—	—	—	—	—	3.3
Butter, - - -	2.8	—	34.4	—	—	—	—	—	16.2
Cheese, - - -	.7	3.3	3.7	.1	—	—	—	—	2.3
Milk, - - -	21.2	12.3	12.7	5.0	—	—	—	—	10.9
Mince meat, - -	.2	.2	—	.5	—	—	—	—	.6
Total animal food, -	43.6	64.2	88.1	5.9	—	—	—	—	68.7
Cereals, sugar, starch,	16.2	24.3	6.8	60.4	—	—	—	—	12.9
Vegetables, - -	23.2	7.8	1.1	21.3	—	—	—	—	6.8
Fruits, - - -	17.0	3.7	4.0	12.4	—	—	—	—	11.6
Total vegetable food,	56.4	35.8	11.9	94.1	—	—	—	—	31.3
Total food, - -	100.0	100.0	100.0	100.0	—	—	—	—	100.0

TABLE 35.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of a Chemist's Family.

FOOD MATERIALS.		Cost.	NUTRIENTS.			Fuel Value.
			Protein.	Fat.	Carbo-hydrates.	
For Family, 28 Days.		$	Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	11.65	4,809	7,735	1,647	98,400
	Vegetable,	5.31	2,676	1,046	26,085	127,650
	Total,	16.96	7,485	8,781	27,732	226,050
Waste,	Animal,	.22	101	1,720	5	16,430
	Vegetable,	.05	66	6	464	2,230
	Total,	.27	167	1,726	469	18,660
Food actually eaten,	Animal,	11.43	4,708	6,015	1,642	81,970
	Vegetable,	5.26	2,610	1,040	25,621	125,420
	Total,	16.69	7,318	7,055	27,263	207,390
Per Man per Day.						
Food purchased,	Animal,	.16	67	107	23	1,365
	Vegetable,	.08	37	15	362	1,775
	Total,	.24	104	122	385	3,140
Waste,	Animal,	—	1	24	—	225
	Vegetable,	—	1	—	7	35
	Total,	—	2	24	7	260
Food actually eaten,	Animal,	.16	66	83	23	1,140
	Vegetable,	.08	36	15	355	1,740
	Total,	.24	102	98	378	2,880
Percentages of Total Food Purchased.						
		%	%	%	%	%
Food purchased,	Animal,	68.7	64.2	88.1	5.9	43.5
	Vegetable,	31.3	35.8	11.9	94.1	56.5
	Total,	100.0	100.0	100.0	100.0	100.0
Waste,	Animal,	1.3	1.3	19.6	—	7.3
	Vegetable,	.3	.9	.1	1.7	1.0
	Total,	1.6	2.2	19.7	1.7	8.3
Food actually eaten,	Animal,	67.4	62.9	68.5	5.9	36.2
	Vegetable,	31.0	34.9	11.8	92.4	55.5
	Total,	98.4	97.8	80.3	98.3	91.7

No. 27. DIETARY OF A FARMER'S FAMILY IN VERMONT.

The study began December 24, 1894, and continued 9⅔ days. The members of the family and number of meals taken were as follows:

Man, 84 years old,	29 meals.
Man, 44 years old,	29 meals.
Woman, 44 years old (29 x .8), equivalent to	23 meals.
Man, 20 years old,	29 meals.
Boy, 17 years old (29 x .8), equivalent to	23 meals.
Boy, 13 years old (29 x .6), equivalent to	17 meals.
Girl, 10 years old (29 x .6), equivalent to	17 meals.
Girl, 2 years old (29 x .4), equivalent to	12 meals.
Total number of meals taken equivalent to	179 meals.

TABLE 36.

Food Materials and Table and Kitchen Wastes in Dietary of a Farmer's Family in Vermont.

Food Materials.	Percentage Composition.			Weight Used.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
ANIMAL FOOD.	%	%	%	Grams.	Grams.	Grams.	Grams.
Beef.							
Flank,	17.9	21.5	—	2,270	406	488	—
Round,	18.1	12.6	—	2,900	525	365	—
Tongue (fresh),	14.8	15.3	—	170	25	26	—
Total,	—	—	—	5,340	956	879	—
Pork.							
Salt pork,	1.8	87.2	—	1,580	28	1,378	—
Sausage,	12.8	45.4	.8	1,800	230	817	15
Lard,	—	100.0	—	450	—	450	—
Total,	—	—	—	3,830	258	2,645	15
Fish, Etc.							
Oysters, "solids,"	6.1	1.4	3.3	900	55	12	30
Butter,	—	82.4	—	1,360	—	1,121	—
Cheese,	26.0	34.2	2.3	340	88	116	8
Cream,	2.5	18.5	4.5	900	22	167	40
Total animal food,	—	—	—	12,670	1,379	4,940	93
VEGETABLE FOOD.							
Cereals, Sugar, Etc.							
Corn meal,	8.9	2.2	75.1	1,220	109	27	916
Flour, rye,	7.1	.9	78.5	910	65	8	714
Flour, wheat,	11.3	1.1	74.6	6,690	756	73	4,991
Bread,	9.5	1.2	52.8	7,665	729	92	4,051
Crackers,	10.7	9.9	68.8	2,080	223	206	1,431
Sugar,	—	—	100.0	4,300	—	—	4,300
Molasses and syrup,	—	—	70.0	3,960	—	—	2,772
Total,	—	—	—	26,825	1,882	406	19,175

TABLE 36.—*(Continued.)*

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			WEIGHT USED.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
VEGETABLE FOOD.—(*Con.*)	%	%	%	Grams.	Grams.	Grams.	Grams.
Vegetables.							
Beans,	22.3	1.8	59.1	1,360	303	24	804
Onions,	1.5	.4	8.9	5,200	78	21	463
Potatoes (15 % refuse),	2.1	.1	18.0	18,140	381	18	3,265
Total,	—	—	—	24,700	762	63	4,532
Fruits, Nuts, Etc.							
Apples,	.4	.4	12.4	22,700	91	91	2,815
Total vegetable food,	—	—	—	74,225	2,735	560	26,522
Total food,	—	—	—	86,895	4,114	5,500	26,615

TABLE 37.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of a Farmer's Family in Vermont.

FOOD MATERIALS.		NUTRIENTS.			FUEL VALUE.
		Protein.	Fat.	Carbohydrates.	
For Family, 9⅔ Days.		Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	1,379	4,940	93	51,980
	Vegetable,	2,735	560	26,522	125,160
	Total,	4,114	5,500	26,615	177,140
Per Man per Day.					
Food purchased,	Animal,	23	82	2	865
	Vegetable,	46	10	442	2,095
	Total,	69	92	444	2,960
Percentages of Total Food Purchased.		%	%	%	%
Food purchased,	Animal,	33.5	89.8	.4	29.3
	Vegetable,	66.5	10.2	99.6	70.7
	Total,	100.0	100.0	100.0	100.0

TABLE 38.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of a Farmer's Family in Vermont.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.			
	Food Material.	Nutrients.			Food Material.	Nutrients.		
		Protein.	Fat.	Carbohydrates.		Protein.	Fat.	Carbohydrates.
For Family, 9⅔ Days.	Grams.	Grams.	Grams.	Grams.	Lbs.	Lbs.	Lbs.	Lbs.
Beef, veal and mutton,	5,340	956	879	—	11.8	2.1	1.9	—
Pork, lard, etc., - -	3,830	258	2,645	15	8.4	.6	5.8	—
Fish, etc., - - -	900	55	12	30	2.0	.1	—	.1
Butter, - - -	1,360	—	1,121	—	3.0	—	2.5	—
Cheese, - - -	340	88	116	8	.7	.2	.3	—
Cream, - - -	900	22	167	40	2.0	—	.4	.1
Total animal food, -	12,670	1,379	4,940	93	27.9	3.0	10.9	.2
Cereals, sugar, starch,	26,825	1,882	406	19,175	59.1	4.1	.9	42.3
Vegetables, - -	24,700	762	63	4,532	54.5	1.7	.1	10.0
Fruits, - - -	22,700	91	91	2,815	50.0	.2	.2	6.2
Total vegetable food,	74,225	2,735	560	26,522	163.6	6.0	1.2	58.5
Total food, - -	86,895	4,114	5,500	26,615	191.5	9.0	12.1	58.7
Per Man per Day.								
Beef, veal and mutton,	89	16	14	—	.20	.04	.03	—
Pork, lard, etc., - -	64	4	44	—	.14	.01	.10	—
Fish, etc., - - -	15	1	—	1	.03	—	—	—
Butter, - - -	22	—	19	—	.05	—	.04	—
Cheese, - - -	6	2	2	—	.01	—	—	—
Cream, - - -	15	—	3	1	.04	—	.01	—
Total animal food, -	211	23	82	2	.47	.05	.18	—
Cereals, sugar, starch,	447	31	7	320	.98	.07	.02	.71
Vegetables, - -	412	13	1	75	.91	.03	—	.17
Fruits, - - -	378	2	2	47	.84	—	—	.10
Total vegetable food,	1,237	46	10	442	2.73	.10	.02	.98
Total food, - -	1,448	69	92	444	3.20	.15	.20	.98
Percentages Total Food.	%	%	%	%				
Beef, veal and mutton,	6.2	23.3	16.0	—	—	—	—	—
Pork, lard, etc., - -	4.4	6.3	48.1	.1	—	—	—	—
Fish, etc., - - -	1.0	1.3	.2	.1	—	—	—	—
Butter, - - -	1.6	—	20.4	—	—	—	—	—
Cheese, - - -	.4	2.1	2.1	—	—	—	—	—
Cream, - - -	1.0	.5	3.0	.2	—	—	—	—
Total animal food, -	14.6	33.5	89.8	.4	—	—	—	—
Cereals, sugar, starch,	30.9	45.8	7.4	72.0	—	—	—	—
Vegetables, - -	28.4	18.5	1.1	17.0	—	—	—	—
Fruits, - - -	26.1	2.2	1.7	10.6	—	—	—	—
Total vegetable food,	85.4	66.5	10.2	99.6	—	—	—	—
Total food, - -	100.0	100.0	100.0	100.0	—	—	—	—

No. 28. DIETARY OF A CHEMIST'S FAMILY.

The study began January 28, 1895, and continued 7 days. The family was the same as in dietary No. 26. The members of the family and number of meals taken were as follows:

Man, 26 years old,	21 meals.
Woman, 25 years old (21 x .8), equivalent to	17 meals.
Servant, 16 years old (9 x .8), equivalent to	7 meals.
Total number of meals taken,	45 meals.

Equivalent to one man 15 days.

TABLE 39.

Food Materials and Table and Kitchen Wastes in Dietary of a Chemist's Family.

Food Materials.	Percentage Composition.			Total Cost.	Weight Used.			
					Total Food Material.	Nutrients.		
	Protein.	Fat.	Carbohydrates.			Protein.	Fat.	Carbohydrates.
ANIMAL FOOD.	%	%	%	$	Grams.	Grams	Grams	Grams
Beef.								
Shoulder clod,	19.3	11.3	—	.27	1,220	24	138	—
Cooked meat,	27.9	11.0	—	.04	170	37	19	—
Dried and smoked,	31.8	6.8	.6	.06	100	32	7	—
Total,	—	—	—	.37	1,490	93	164	—
Mutton.								
Chops,	13.2	28.6	—	.24	680	90	194	—
Pork.								
Spare rib,	14.1	25.6	—	.30	1,135	160	291	—
Lard,	—	100.0	—	.06	200	—	200	—
Total,	—	—	—	.36	1,335	160	491	—
Fish, Etc.								
Oysters, "solids,"	6.1	1.4	3.3	.24	565	34	8	19
Clams, long, shell contents,	8.6	1.0	2.0	.26	595	51	6	12
Total,	—	—	—	.50	1,160	85	14	31
Eggs,	13.1	9.5	—	.03	75	10	7	—
Butter,	—	82.4	—	.55	740	—	610	—
Cheese,	26.0	34.2	2.3	.12	340	88	116	8
Milk,	3.3	4.0	5.0	.56	8,465	279	339	423
Total animal food,	—	—	—	2.73	14,285	805	1,935	462

TABLE 39.—*(Continued.)*

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			TOTAL COST.	WEIGHT USED.			
					TOTAL FOOD MATERIAL.	NUTRIENTS.		
	Protein.	Fat.	Carbohydrates.			Protein.	Ash.	Carbohydrates.
VEGETABLE FOOD. *Cereals, Sugar, Etc.*	%	%	%	$	Grams.	Grams	Grams	Grams
Corn meal,	8.9	2.2	75.1	.03	500	44	11	376
Flour, rye,	7.1	.9	78.5	.04	545	39	5	428
Flour, wheat,	11.3	1.1	74.6	.04	795	90	9	593
Oatmeal,	15.6	7.3	68.0	.02	200	31	15	136
Rice,	7.8	.4	79.0	.01	60	5	—	47
Bread,	9.5	1.2	52.8	.06	680	65	8	359
Cake and cookies,	7.0	8.1	63.4	.04	225	16	18	143
Crackers, cream,	9.3	13.1	69.2	.09	470	44	62	325
Crackers, oyster,	11.0	8.8	74.2	.09	455	50	40	338
Starch,	—	—	98.0	.02	85	—	—	83
Tapioca,	.4	.3	87.5	.04	175	1	—	153
Sugar,	—	—	100.0	.10	950	—	—	950
Maple syrup,	—	—	70.0	.02	100	—	—	70
Cocoa,	21.6	28.9	37.7	.01	30	6	9	11
Total,	—	—	—	.61	5,270	391	177	4,012
Vegetables.								
Potatoes (15 % refuse),	2.1	.1	18.0	.12	3,740	79	4	673
Fruits, Nuts, Etc.								
Apples,	.4	.4	12.4	.07	2,055	8	8	255
Plums, canned,	.8	2.1	56.4	.20	910	7	19	513
Peanuts,	17.3	25.9	16.3	.13	400	69	104	65
Total,	—	—	—	.40	3,365	84	131	833
Total vegetable food,	—	—	—	1.13	12,375	554	312	5,518
Total food,	—	—	—	3.86	26,660	1,359	2,247	5,980

TABLE 40.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of a Chemist's Family.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.				
	Food Material.	Nutrients.			Food Material.	Nutrients.			Cost.
		Protein.	Fat.	Carbohydrates.		Protein.	Fat.	Carbohydrates.	
For Family, 7 Days.	Grams	Grams	Grams	Grams	Lbs.	Lbs.	Lbs.	Lbs.	$
Beef, veal and mutton,	2,170	183	358	—	4.8	.4	.8	—	.61
Pork, lard, etc.,	1,335	160	491	—	2.9	.4	1.1	—	.36
Fish, etc.,	1,160	85	14	31	2.6	.2	—	.1	.50
Eggs,	75	10	7	—	.2	—	—	—	.03
Butter,	740	—	610	—	1.6	—	1.3	—	.55
Cheese,	340	88	116	8	.7	.2	.3	—	.12
Milk,	8,465	279	339	423	18.7	.6	.8	.9	.56
Total animal food,	14,285	805	1,935	462	31.5	1.8	4.3	1.0	2.73
Cereals, sugar, starch,	5,270	391	177	4,012	11.6	.8	.4	8.9	.61
Vegetables,	3,740	79	4	673	8.3	.2	—	1.5	.12
Fruits,	3,365	84	131	833	7.4	.2	.3	1.8	.40
Total vegetable food,	12,375	554	312	5,518	27.3	1.2	.7	12.2	1.13
Total food,	26,660	1,359	2,247	5,980	58.8	3.0	5.0	13.2	3.86
Per Man per Day.									
Beef, veal and mutton,	145	12	24	—	.32	.03	.05	—	—
Pork, lard, etc.,	89	11	33	—	.20	03	.07	—	—
Fish, etc.,	77	6	1	2	.17	.01	—	.01	—
Eggs,	5	1	—	—	.01	—	—	—	—
Butter,	49	—	41	—	.11	—	.09	—	—
Cheese,	23	6	7	1	.05	.01	.02	—	—
Milk,	564	18	23	28	1.24	.04	.05	.06	—
Total animal food,	952	54	129	31	2.10	.12	.28	.07	.18
Cereals, sugar, starch,	351	26	12	267	.77	.06	.03	.59	—
Vegetables,	250	5	—	45	.55	.01	—	.10	—
Fruits,	224	6	9	56	.50	.01	.02	.12	—
Total vegetable food,	825	37	21	368	1.82	.08	.05	.81	.08
Total food,	1,777	91	150	399	3.92	.20	.33	.88	.26
Percentages Total Food.	%	%	%	%					%
Beef, veal and mutton,	8.1	13.5	15.9	—	—	—	—	—	15.8
Pork, lard, etc.,	5.0	11.8	21.9	—	—	—	—	—	9.3
Fish, etc.,	4.4	6.2	.6	.5	—	—	—	—	13.0
Eggs,	.3	.7	.3	—	—	—	—	—	.8
Butter,	2.8	—	27.1	—	—	—	—	—	14.2
Cheese,	1.2	6.5	5.2	.1	—	—	—	—	3.1
Milk,	31.8	20.5	15.1	7.1	—	—	—	—	14.5
Total animal food,	53.6	59.2	86.1	7.7	—	—	—	—	70.7
Cereals, sugar, starch,	19.8	28.8	7.9	67.1	—	—	—	—	15.8
Vegetables,	14.0	5.8	.2	11.3	—	—	—	—	3.1
Fruits,	12.6	6 2	5.8	13.9	—	—	—	—	10.4
Total vegetable food,	46.4	40.8	13.9	92.3	—	—	—	—	29.3
Total food,	100.0	100.0	100.0	100.0	—	—	—	—	100.0

TABLE 41.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of a Chemist's Family.

Food Materials.		Cost.	Nutrients.			Fuel Value.
			Protein.	Fat.	Carbo-hydrates.	
For Family, 7 Days.		$	Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	2.73	805	1,935	462	23,190
	Vegetable,	1.13	554	312	5,518	27,800
	Total,	3.86	1,359	2,247	5,980	50,990
Food actually eaten,	Animal,	2.73	805	1,935	462	23,190
	Vegetable,	1.13	554	312	5,518	27,800
	Total,	3.86	1,359	2,247	5,980	50,990
Per Man per Day.						
Food purchased,	Animal,	.18	54	129	31	1,550
	Vegetable,	.08	37	21	368	1,855
	Total,	.26	91	150	399	3,405
Food actually eaten,	Animal,	.18	54	129	31	1,550
	Vegetable,	.08	37	21	368	1,855
	Total,	.26	91	150	399	3,405
Percentages of Total Food Purchased.		%	%	%	%	%
Food purchased,	Animal,	70.7	59.2	86.1	7.7	45.5
	Vegetable,	29.3	40.8	13.9	92.3	54.5
	Total,	100.0	100.0	100.0	100.0	100.0
Food actually eaten,	Animal,	70.7	59.2	86.1	7.7	45.5
	Vegetable,	29.3	40.8	13.9	92.3	54.5
	Total,	100.0	100.0	100.0	100.0	100.0

No. 29. DIETARY OF A CHEMIST'S FAMILY.

The study began April 6, 1895, and continued 21 days. The family was the same as in dietaries Nos. 26 and 28. The members of the family and number of meals taken were as follows:

Man, 26 years old,	60 meals.
Woman, 25 years old (60 x .8), equivalent to	48 meals.
Servant, 16 years old (52 x .8), equivalent to	42 meals.
Man (college student*), 20 years old,	9 meals.
Total number of meals taken equivalent to	159 meals.

Equivalent to one man 53 days.

TABLE 42.

Food Materials and Table and Kitchen Wastes in Dietary of a Chemist's Family.

Food Materials.	Percentage Composition.			Total Cost.	Weight Used.			
						Nutrients.		
	Protein.	Fat.	Carbohydrates.		Total Food Material.	Protein.	Ash.	Carbohydrates.
Animal Food.	%	%	%	¢	Grams.	Grams.	Grams.	Grams.
Beef.								
Chuck, no bone,	19.0	12.3	—	.43	1,615	307	198	—
Shoulder clod,	19.3	11.3	—	.58	2,610	504	295	—
Round, no bone,	19.7	13.5	—	.73	2,380	828	567	—
Round, 2d cut, no bone,	20.6	8.6	—	.21	1,250	257	108	—
Cooked meat,	27.9	11.0	—	.03	225	63	25	—
Rump, corned,	14.4	22.0	—	.44	1,560	225	343	—
Total,	—	—	—	2.42	9,640	2,184	1,536	—
Veal.								
Shoulder,	16.6	8.7	—	.30	1,135	188	99	—
Leg,	16.9	7.2	—	.33	1,590	269	114	—
Total,	—	—	—	.63	2,725	457	213	—
Pork.								
Chops,	14.1	25.6	—	.39	1,590	224	407	—
Salt pork,	1.8	87.2	—	.06	225	4	196	—
Cottolene,	—	100.0	—	.29	1,080	—	1,080	—
Total,	—	—	—	.74	2,895	228	1,683	—
Fish.								
Cod, fresh,	10.6	.2	—	.20	680	72	1	—
Shad,	9.2	4.8	—	.25	1,135	104	55	—
Total,	—	—	—	.45	1,815	176	56	—
Eggs,	13.1	9.5	—	.86	3,015	395	286	—
Butter,	—	82.4	—	2.17	2,895	—	2,385	—
Cheese,	26.0	34.2	2.3	.14	410	107	140	9
Milk,	3.3	4.0	5.0	1.58	26,795	884	1,072	1,340
Total animal food,	—	—	—	8.99	50,190	4,431	7,371	1,349

* Took dinner with the family four times a week.

TABLE 42.—*(Continued.)*

Food Materials.	Percentage Composition.			Total Cost.	Weight Used.			
	Protein.	Fat.	Carbohydrates.		Total Food Material.	Nutrients. Protein.	Fat.	Carbohydrates.
VEGETABLE FOOD.	%	%	%	$	Grams.	Grams.	Grams.	Grams.
Cereals, Sugar, Etc.								
Corn meal,	8.9	2.2	75.1	.10	1,915	170	42	1,438
Flour, rye,	7.1	.9	78.5	.10	1,535	109	14	1,205
Flour, wheat,	11.3	1.1	74.6	.32	5,845	660	64	4,361
Oatmeal,	15.6	7.3	68.0	.13	1,195	186	87	813
Rice,	7.8	.4	79.0	.15	855	67	3	675
Wheatlet,	12.3	1.4	75.0	.03	225	28	32	169
Crackers, cream,	9.3	13.1	69.2	.37	1,885	175	247	1,304
Starch,	—	—	98.0	.04	180	—	—	176
Sugar,	—	—	100.0	.63	4,320	—	—	4,320
Molasses,	2.7	—	68.0	.25	1,515	41	—	1,030
Chocolate,	12.5	47.1	26.8	.06	60	8	28	16
Total,	—	—	—	2.18	19,530	1,444	517	15,507
Vegetables.								
Beans, dried,	22.3	1.8	59.1	.11	1,020	227	18	603
Potatoes (15 % refuse),	2.1	.1	18.0	.38	11,590	243	12	2,086
Sweet potatoes (12½ % refuse),	1.8	.7	27.1	.06	950	17	7	257
Total,	—	—	—	.55	13,560	487	37	2,946
Fruits, Nuts, Etc.								
Apples, flesh,	.5	.5	16.6	.29	4,370	22	22	725
Bananas, pulp,	1.2	.8	22.9	.10	1,560	19	12	357
Jelly,	1.1	—	77.1	.15	340	4	—	262
Lemons, pulp,	1.0	.9	8.3	.05	200	2	2	16
Oranges, pulp,	.8	.6	9.7	.26	1,020	8	6	99
Raisins,	2.5	4.7	74.7	.01	50	1	2	38
Prunes, dry, flesh,	2.4	.8	68.9	.20	740	18	6	510
Peanuts (33 % refuse),	25.8	38.6	24.4	.18	555	143	214	135
Total,	—	—	—	1.24	8,835	217	264	2,142
Total vegetable food,	—	—	—	3.97	41,925	2,148	818	20,595
Total food,	—	—	—	12.96	92,115	6,579	8,189	21,944
Waste—Table and Kitchen.								
Cooked meat,	27.9	11.0	—	.03	100	28	11	—
Fat,*	—	90.0	—	.03	425	—	383	—
Cheese, rind,	26.0	34.2	2.3	.02	60	16	21	1
Bread,	9.5	1.2	52.8	.02	200	19	2	106
Flour,	11.3	1.1	74.6	.01	100	11	1	75
Potatoes,	2.1	.1	18.0	.01	215	4	—	39
Total,	—	—	—	.12	1,100	78	418	221

* Estimated 90 % fat.

TABLE 43.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of a Chemist's Family.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.				
	Food Material.	Nutrients.			Food Material.	Nutrients.			Cost.
		Protein.	Fat.	Carbo-hydrates.		Protein.	Fat.	Carbo-hydrates.	
For Family, 21 Days.	Grams	Grams	Grams	Grams	Lbs.	Lbs.	Lbs.	Lbs.	$
Beef, veal and mutton,	12,365	2,641	1,749	—	27.3	5.8	3.9	—	3.05
Pork, lard, etc.,	2,895	228	1,683	—	6.4	.5	3.7	—	.74
Fish, etc.,	1,815	176	56	—	4.0	.4	.1	—	.45
Eggs,	3,015	395	286	—	6.6	.9	.6	—	.86
Butter,	2,895	—	2,385	—	6.4	—	5.3	—	2.17
Cheese,	410	107	140	9	.9	.2	.3	—	.14
Milk,	26,795	884	1,072	1,340	59.1	2.0	2.4	3.0	1.58
Total animal food,	50,190	4,431	7,371	1,349	110.7	9.8	16.3	3.0	8.99
Cereals, sugar, starch,	19,530	1,444	517	15,507	43.0	3.2	1.1	34.2	2.18
Vegetables,	13,560	487	37	2,946	29.9	1.0	.1	6.5	.55
Fruits,	8,835	217	264	2,142	19.5	.5	.6	4.7	1.24
Total vegetable food,	41,925	2,148	818	20,595	92.4	4.7	1.8	45.4	3.97
Total food,	92,115	6,579	8,189	21,944	203.1	14.5	18.1	48.4	12.96
Per Man per Day.									
Beef, veal and mutton,	233	50	33	—	.51	.11	.07	—	—
Pork, lard, etc.,	55	4	32	—	.12	.01	.07	—	—
Fish, etc.,	34	3	1	—	.08	—	—	—	—
Eggs,	57	8	5	—	.13	.02	.01	—	—
Butter,	55	—	45	—	.12	—	.10	—	—
Cheese,	8	2	3	—	.02	—	.01	—	—
Milk,	505	17	20	25	1.11	.04	.05	.05	—
Total animal food,	947	84	139	25	2.09	.18	.31	.05	.07
Cereals, sugar, starch,	368	27	10	293	.81	.06	.02	.65	—
Vegetables,	256	9	1	56	.56	.02	—	.12	—
Fruits,	167	4	5	40	.37	.01	.01	.09	—
Total vegetable food,	791	40	16	389	1.74	.09	.03	.86	.17
Total food,	1,738	124	155	414	3.83	.27	.34	.91	.24
Percentages Total Food.	%	%	%	%					%
Beef, veal and mutton,	13.4	40.1	21.4	—	—	—	—	—	23.5
Pork, lard, etc.,	3.1	3.5	20.5	—	—	—	—	—	5.7
Fish, etc.,	2.0	2.7	.7	—	—	—	—	—	3.5
Eggs,	3.3	6.0	3.5	—	—	—	—	—	6.6
Butter,	3.1	—	29.1	—	—	—	—	—	16.8
Cheese,	.5	1.6	1.7	—	—	—	—	—	1.1
Milk,	29.1	13.4	13.1	6.1	—	—	—	—	12.2
Total animal food,	54.5	67.3	90.0	6.1	—	—	—	—	69.4
Cereals, sugar, starch,	21.2	22.0	6.3	70.7	—	—	—	—	16.8
Vegetables,	14.7	7.4	.5	13.4	—	—	—	—	4.2
Fruits,	9.6	3.3	3.2	9.8	—	—	—	—	9.6
Total vegetable food,	45.5	32.7	10.0	93.9	—	—	—	—	30.6
Total food,	100.0	100.0	100.0	100.1	—	—	—	—	100.0

TABLE 44.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of a Chemist's Family.

Food Materials.		Cost.	Nutrients.			Fuel Value.
			Protein.	Fat.	Carbo-hydrates.	
For Family, 21 Days,		$	Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	8.99	4,431	7,371	1,349	92,250
	Vegetable,	3.97	2,148	818	20,595	100,850
	Total,	12.96	6,579	8,189	21,944	193,100
Waste,	Animal,	.08	44	415	1	4,040
	Vegetable,	.04	34	3	220	1,070
	Total,	.12	78	418	221	5,110
Food actually eaten,	Animal,	8.91	4,387	6,956	1,348	88,210
	Vegetable,	3.93	2,114	815	20,375	99,780
	Total,	12.84	6,501	7,771	21,723	187,990
Per Man per Day.						
Food purchased,	Animal,	.07	84	139	25	1,740
	Vegetable,	.17	40	16	389	1,910
	Total,	.24	124	155	414	3,650
Waste,	Animal,	—	1	8	—	80
	Vegetable,	—	1	—	4	20
	Total,	—	2	8	4	100
Food actually eaten,	Animal,	.07	83	131	25	1,660
	Vegetable,	.17	39	16	385	1,890
	Total,	.24	122	147	410	3,550
Percentages of Total Food Purchased.		%	%	%	%	%
Food purchased,	Animal,	69 4	67.3	90.0	6.1	47.8
	Vegetable,	30.6	32.7	10.0	93.9	52.2
	Total,	100.0	100.0	100.0	100.0	100.0
Waste,	Animal,	.6	.7	5.1	—	2.1
	Vegetable,	.3	.5	—	1.0	.5
	Total,	.9	1.2	5.1	1.0	2.6
Food actually eaten,	Animal,	68.8	66.6	84.9	6.1	45.7
	Vegetable,	30.3	32.2	10.0	92.9	51.7
	Total,	99.1	98.8	94.9	99.0	97.4

No. 45. DIETARY OF A FARMER'S FAMILY IN CONNECTICUT.

The study began the first part of December, 1894, and continued 7 days. The members of the family and number of meals taken were as follows:

Farmer, 30 years old, at hard muscular work,	21 meals.
Hired man, 18 years old at hard muscular work,	19 meals.
Woman, 34 years old, at hard work (21 x .8), equivalent to	17 meals.
Boy, 7 years old (17 x .5), equivalent to	9 meals.
Girl, 4 years old (21 x .4), equivalent to	8 meals.
Child (21 x .3), equivalent to	6 meals.
Total number of meals taken equivalent to	80 meals.

Equivalent to one man 27 days.

Remarks.—There was no waste. The hired man "always cleared the table."

TABLE 45.

Food Materials and Table and Kitchen Wastes in Dietary of a Farmer's Family in Connecticut.

Food Materials.	Percentage Composition.			Weight Used.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
ANIMAL FOOD.	%	%	%	Grams.	Grams.	Grams.	Grams.
Beef.							
Round steak, no bone *(a)*,	19.5	14.4	—	1,700	332	245	—
Pork.							
Lard,	—	100.0	—	738	—	738	—
Poultry.							
Chicken,	14.8	1.1	—	2,290	339	25	—
Butter,	—	82.4	—	455	—	375	—
Milk *(a)*,	3.5	4.8	4.3	9,000	315	432	387
Total animal food,	—	—	—	14,183	986	1,815	387
VEGETABLE FOOD.							
Cereals, Sugar, Etc.							
Flour, rye *(a)*,	6.3	.8	79.8	4,080	257	33	3,256
Flour, wheat *(a)*,	13.9	1.0	71.4	8,620	1,198	86	6,155
Sugar,	—	—	100.0	2,040	—	—	2,040
Total,	—	—	—	14,740	1,455	119	11,451
Vegetables.							
Cabbage (50 % refuse),	2.1	.4	5.8	3,630	76	15	210
Potatoes (15 % refuse),	2.1	.1	18.0	8,095	170	8	1,457
Pumpkin (50 % refuse),	1.0	.1	5.2	4,535	45	5	236
Squash (50 % refuse),	1.6	.6	10.4	680	11	4	71
Sweet potatoes (12½ % ref.),	1.8	.7	27.1	3,175	57	22	860
Turnips,	1.0	.1	6.1	4,765	48	5	290
Total,	—	—	—	24,880	407	59	3,124
Fruits, Nuts, Etc.							
Apples (25 % refuse),	.5	.5	16.6	13,260	66	66	2,201
Total vegetable food,	—	—	—	52,880	1,928	244	16,776
Total food,	—	—	—	67,063	2,914	2,059	17,163

TABLE 46.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of a Farmer's Family in Connecticut.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.			
	Food Material.	Nutrients.			Food Material.	Nutrients.		
		Protein.	Fat.	Carbohydrates.		Protein.	Fat.	Carbohydrates.
For Family, 7 Days.	Grams.	Grams.	Grams.	Grams.	Lbs.	Lbs.	Lbs.	Lbs.
Beef, veal and mutton,	1,700	332	245	—	3.8	.7	.5	—
Pork, lard, etc.,	738	—	738	—	1.6	—	1.6	—
Poultry,	2,290	339	25	—	5.1	.8	.1	—
Butter,	455	—	375	—	1.0	—	.8	—
Milk,	9,000	315	432	387	19.8	.7	1.0	.8
Total animal food,	14,183	986	1,815	387	31.3	2.2	4.0	.8
Cereals, sugar, starch,	14,740	1,455	119	11,451	32.5	3.2	.3	25.2
Vegetables,	24,880	407	59	3,124	54.9	.9	.1	6.9
Fruits,	13,260	66	66	2,201	29.2	.1	.1	4.9
Total vegetable food,	52,880	1,928	244	16,776	116.6	4.2	.5	37.0
Total food,	67,063	2,914	2,059	17,163	147.9	6.4	4.5	37.8
Per Man per Day.								
Beef, veal and mutton,	63	12	9	—	.14	.03	.02	—
Pork, lard, etc.,	27	—	27	—	.06	—	.06	—
Poultry,	85	13	1	—	.19	.03	—	—
Butter,	17	—	14	—	.04	—	.03	—
Milk,	333	12	16	14	.73	.02	.04	.03
Total animal food,	525	37	67	14	1.16	.08	.15	.03
Cereals, sugar, starch,	546	54	5	424	1.21	.12	.01	.94
Vegetables,	922	15	2	116	2.03	.03	—	.25
Fruits,	491	2	2	81	1.08	.01	.01	.18
Total vegetable food,	1,959	71	9	621	4.32	.16	.02	1.37
Total food,	2,484	108	76	635	5.48	.24	.17	1.40
Percentages Total Food.	%	%	%	%				
Beef, veal and mutton,	2.5	11.4	11.9	—	—	—	—	—
Pork, lard, etc.,	1.1	—	35.8	—	—	—	—	—
Poultry,	3.4	11.6	1.2	—	—	—	—	—
Butter,	.7	—	18.2	—	—	—	—	—
Milk,	13.4	10.8	21.0	2.3	—	—	—	—
Total animal food,	21.1	33.8	88.1	2.3	—	—	—	—
Cereals, sugar, starch,	22.0	49.9	5.8	66.7	—	—	—	—
Vegetables,	37.1	14.0	2.9	18.2	—	—	—	—
Fruits,	19.8	2.3	3.2	12.8	—	—	—	—
Total vegetable food,	78.9	66.2	11.9	97.7	—	—	—	—
Total food,	100.0	100.0	100.0	100.0	—	—	—	—

TABLE 47.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of a Farmer's Family in Connecticut.

FOOD MATERIALS.		Nutrients.			Fuel Value.
		Protein.	Fat.	Carbo-hydrates.	
For Family, 7 Days,		Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	986	1,815	387	22,510
	Vegetable,	1,928	244	16,775	78,950
	Total,	2,914	2,059	17,162	101,460
Food actually eaten,*	Animal,	986	1,815	387	22,510
	Vegetable,	1,928	244	16,775	78,950
	Total,	2,914	2,059	17,162	101,460
Per Man per Day.					
Food purchased,	Animal,	37	67	14	835
	Vegetable,	71	9	621	2,920
	Total,	108	76	635	3,755
Food actually eaten,	Animal,	37	67	14	835
	Vegetable,	71	9	621	2,920
	Total,	108	76	635	3,755
Percentages of Total Food Purchased.		%	%	%	%
Food purchased,	Animal,	33.8	88.1	2.3	22.2
	Vegetable,	66.2	11.9	97.7	77.8
	Total,	100.0	100.0	100.0	100.0
Food actually eaten,	Animal,	33.8	88.1	2.3	22.2
	Vegetable,	66.2	11.9	97.7	77.8
	Total,	100.0	100.0	100.0	100.0

* No "waste" in this dietary.

No. 46. DIETARY OF A FARMER'S FAMILY IN CONNECTICUT.

(SAME FAMILY AS DIETARY No. 45.)

The study began December 17, 1894, and continued 28 days. The members of the family and number of meals taken were as follows:

Farmer, 30 years old, at hard muscular work, - - -	81 meals.
Hired man, 18 years old, at hard muscular work, - -	73 meals.
Woman, 34 years old, at hard work (83 x .8), equivalent to	66 meals.
Boy, 7 years old (80 x .5), equivalent to - - - -	40 meals.
Girl, 4 years old (83 x .4), equivalent to - - - -	33 meals.
Child, 18 months old (83 x .3), equivalent to - - -	25 meals.
Total number of meals taken equivalent to - -	318 meals.

Equivalent to one man 106 days.

TABLE 48.

Food Materials and Table and Kitchen Wastes in Dietary of a Farmer's Family in Connecticut.

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			WEIGHT USED.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
ANIMAL FOOD.	%	%	%	Grams.	Grams.	Grams.	Grams.
Beef.							
Round steak, no bone *(a)*,	19.5	14.4	—	8,165	1,594	1,177	—
Pork.							
Salt pork, - - -	1.8	87.2	—	1,250	22	1,090	—
Lard, - - - -	—	100.0	—	3,175	—	3,175	—
Total, - - -	—	—	—	4,425	22	4,265	—
Poultry.							
Chicken, - - -	14.8	1.1	—	4,310	638	47	—
Butter, - - - -	—	82.4	—	225	—	185	—
Milk *(a)*, - - -	3.5	4.8	4.3	60,810	2,128	2,919	2,615
Total animal food, -	—	—	—	77,935	4,382	8,593	2,615
VEGETABLE FOOD.							
Cereals, Sugar, Etc.							
Corn meal *(a)*, - -	9.3	2.5	68.4	4,990	464	125	3,413
Flour, bread *(a)*, - -	13.9	1.0	71.4	11,115	1,547	111	7,943
Flour, pastry *(a)*, - -	10.6	1.0	73.3	17,690	1,875	177	12,967
Flour, rye *(a)*, - -	6.3	.8	79.8	9,355	589	75	7,466
Crackers, milk, - -	9.3	13.1	69.2	2,835	264	371	1,962
Sugar, granulated, - -	—	—	100.0	8,170	—	—	8,170
Molasses, - - -	2.7	—	68.0	8,510	230	—	5,786
Total, - - -	—	—	—	62,665	4,969	859	47,707
Vegetables.							
Beans (dry), - - -	22.3	1.8	59.1	3,485	777	63	2,060
Cabbage (30 % refuse), -	2.1	.4	5.8	4,445	93	18	258
Potatoes (15 % refuse), -	2.1	.1	18.0	46,285	972	46	8,330
Squash, - - - -	.8	.3	5.2	2,950	24	9	153
Turnips (30 % refuse), -	1.4	.2	8.7	23,190	325	46	2,018
Total, - - -	—	—	—	80,355	2,191	182	12,819

TABLE 48.—*(Continued.)*

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			WEIGHT USED.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
VEGETABLE FOOD—*(Con.)*	%	%	%	Grams.	Grams.	Grams.	Grams.
Fruits, Nuts, Etc.							
Apples (25 % refuse), -	.5	.5	16.6	5,785	29	29	960
Raisins, - - -	2.5	4.7	74.7	455	11	21	340
Total, - - -	—	—	—	6,240	40	50	1,300
Total vegetable food, -	—	—	—	149,260	7,200	1,091	61,826
Total food, - -	—	—	—	227,195	11,582	9,684	64,441

TABLE 49.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of a Farmer's Family in Connecticut.

FOOD MATERIALS.		NUTRIENTS.			FUEL VALUE.
		Protein.	Fat.	Carbohydrates.	
For Family, 28 Days.		Grams.	Grams.	Grams.	Calories.
Food purchased, - -	Animal, - -	4,382	8,593	2,615	108,600
	Vegetable, - -	7,200	1,091	61,826	293,150
	Total, - -	11,582	9,684	64,441	401,750
Food actually eaten,* -	Animal, - -	4,382	8,593	2,615	108,600
	Vegetable, - -	7,200	1,091	61,826	293,150
	Total, - -	11,582	9,684	64,441	401,750
Per Man per Day.					
Food purchased, - -	Animal, - -	41	81	25	1,025
	Vegetable, - -	68	10	583	2,760
	Total, - -	109	91	608	3,785
Food actually eaten, -	Animal, - -	41	81	25	1,025
	Vegetable, - -	68	10	583	2,760
	Total, - -	109	91	608	3,785
Percentages of Total Food Purchased.					
Food purchased, - -	Animal, - -	37.8	88.7	4.1	27.0
	Vegetables, - -	62.2	11.3	95.9	73.0
	Total, - -	100.0	100.0	100.0	100.0
Food actually eaten, -	Animal, - -	37.8	88.7	4.1	27.0
	Vegetable, - -	62.2	11.3	95.9	73.0
	Total, - -	100.0	100.0	100.0	100.0

* No "waste" in this dietary.

TABLE 50.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of a Farmer's Family in Connecticut.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.			
	Food Material.	Nutrients.			Food Material.	Nutrients.		
		Protein.	Fat.	Carbo-hydrates.		Protein.	Fat.	Carbo-hydrates.
For Family, 28 Days.	Grams.	Grams.	Grams.	Grams.	Lbs.	Lbs.	Lbs.	Lbs.
Beef, veal and mutton,	8,165	1,594	1,177	—	18.0	3.5	2.6	—
Pork, lard, etc., - -	4,425	22	4,265	—	9.7	—	9.4	—
Poultry, - - -	4,310	638	47	—	9.5	1.4	.1	—
Butter, - - -	225	—	185	—	.5	—	.4	—
Milk, - - - -	60,810	2,128	2,919	2,615	134.1	4.7	6.4	5.8
Total animal food, -	77,935	4,382	8,593	2,615	171.8	9.6	18.9	5.8
Cereals, sugar, starch, -	62,665	4,969	859	47,707	138.2	11.0	1.9	105.2
Vegetables, - - -	80,355	2,191	182	12,819	177.2	4.8	.4	28.2
Fruits, - - -	6,240	40	50	1,300	13.7	.1	.1	2.9
Total vegetable food,	149,260	7,200	1,091	61,826	329.1	15.9	2.4	136.3
Total food, - -	227,195	11,582	9,684	64,441	500.9	25.5	21.3	142.1
Per Man per Day.								
Beef, veal and mutton,	77	15	11	—	.17	.03	.03	—
Pork, lard, etc., - -	42	—	40	—	.09	—	.09	—
Poultry, - - -	40	6	—	—	.09	.01	—	—
Butter, - - -	2	—	2	—	—	—	—	—
Milk, - - - -	574	20	28	25	1.26	.05	.06	.06
Total animal food, -	735	41	81	25	1.61	.09	.18	.06
Cereals, sugar, starch, -	591	47	8	450	1.31	.10	.02	.99
Vegetables, - - -	758	21	2	121	1.67	.05	—	.27
Fruits, - - -	59	—	—	12	.13	—	—	.02
Total vegetable food,	1,408	68	10	583	3.11	.15	.02	1.28
Total food, - -	2,143	109	91	608	4.72	.24	.20	1.34
Percentages Total Food.	%	%	%	%				
Beef, veal and mutton,	3.6	13.7	12.2	—	—	—	—	—
Pork, lard, etc., - -	1.9	.2	44.0	—	—	—	—	—
Poultry, - - -	1.9	5.5	.5	—	—	—	—	—
Butter, - - -	.1	—	1.9	—	—	—	—	—
Milk, - - - -	26.8	18.4	30.1	4.1	—	—	—	—
Total animal food, -	34.3	37.8	88.7	4.1	—	—	—	—
Cereals, sugar, starch, -	27.6	42.9	8.9	74.0	—	—	—	—
Vegetables, - - -	35.4	18.9	1.9	19.9	—	—	—	—
Fruits, - - -	2.7	.4	.5	2.0	—	—	—	—
Total vegetable food,	65.7	62.2	11.3	95.9	—	—	—	—
Total food, - -	100.0	100.0	100.0	100.0	—	—	—	—

No. 120. DIETARY OF A FARMER'S FAMILY IN CONNECTICUT.

The study began October 10, 1895, and continued 28 days. The members of the family were as follows: Man, about 60 years old, husband; woman, 60 years old, wife; man, 35 years old, son; woman, 30 years old, daughter-in-law; man, 30 years old, son; girl, 6 years old, grand-child; girl, 3 years old, grand-child. The number of meals taken were:

Men,	240 meals.
Women (171 x. 8), equivalent to	137 meals.
Girl (83 x .5), equivalent to	42 meals.
Girl (83 x. 4), equivalent to	33 meals.
Total number of meals taken equivalent to	452 meals.

Equivalent to one man 151 days.

Remarks.—The members of the family were of average weight, and all strong and healthy. The old man was a machinist by trade, but was at home most of the time on his farm, doing a moderate amount of work. The two sons worked hard, as did also the woman. The older girl attended school.

TABLE 51.

Food Materials and Table and Kitchen Wastes in Dietary of a Farmer's Family in Connecticut.

Food Materials.	Percentage Composition.			Weight Used.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
Animal Food.	%	%	%	Grams.	Grams.	Grams.	Grams.
Beef.							
Round,	18.1	12.6	—	7,260	1,314	915	—
Rib,	13.4	21.3	—	4,625	620	985	—
Shoulder clod,	19.3	11.3	—	13,610	2,626	1,538	—
Dried and smoked,	31.8	6.8	.6	1,135	361	77	6
Total,	—	—	—	26,630	4,921	3,515	6
Pork.							
Loin,	14.1	25.6	—	1,270	179	325	—
Ham, lean, smoked,	17.9	18.5	—	6,350	1,137	1,175	—
Salt, fat,	1.8	87.2	—	4,080	73	3,558	—
Lard,	—	100.0	—	2,720	—	2,720	—
Sausage,	12.8	45.4	.8	2,270	290	1,031	18
Total,	—	—	—	16,690	1,679	8,809	18
Poultry.							
Chicken,	14.8	1.1	—	6,305	933	69	—
Fish, Etc.							
Cod, fresh,	10.6	.2	—	1,045	111	2	—
Cod, salt, boneless,	22.2	.3	—	2,360	524	7	—
Haddock, fresh,	8.2	.2	—	2,360	193	5	—
Salmon, canned,	20.7	10.8	1.2	455	94	49	5
Total,	—	—	—	6,220	922	63	5
Eggs,	13.1	9.5	—	1,725	226	164	—
Butter,	—	82.4	—	2,315	—	1,907	—
Cheese,	26.0	34.2	2.3	1,225	319	419	28
Milk, whole *(a)*,	3.4	5.2	5.0	88,725	—	—	—
Milk, skim, not eaten *(a)*,	4.1	.6	5.2	34,475	—	—	—
Milk & cream actually eaten,	—	—	—	54,250	1,604	4,407	2,643
Total animal food,	—	—	—	115,360	10,604	19,353	2,700

TABLE 51.—*(Continued.)*

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			WEIGHT USED.			
					Nutrients.		
	Protein.	Fat.	Carbo-hydrates.	Total Food Material.	Protein.	Fat.	Carbo-hydrates.
VEGETABLE FOOD.	%	%	%	Grams.	Grams.	Grams.	Grams.
Cereals, Sugar, Etc.							
Corn meal,	8.9	2.2	75.1	905	80	20	680
Flour, graham,	13.7	2.2	70.3	225	31	5	158
Flour, bread,	11.3	1.1	74.6	10,660	1,205	117	7,952
Flour, pastry,	10.4	1.0	75.6	15,420	1,604	154	11,657
Flour, rye,	7.1	.9	78.5	4,535	322	41	3,560
Oat meal,	15.6	7.3	68.0	2,270	354	166	1,543
Rolled oats,	16.9	7.2	66.8	2,040	345	147	1,362
Bread,	9.5	1.2	52.8	2,860	272	34	1,510
Crackers, milk,	9.3	13.1	69.2	2,540	236	333	1,758
Sugar, granulated,	—	—	100.0	20,410	—	—	20,410
Sugar, brown,	—	—	95.0	1,225	—	—	1,164
Molasses,	2.7	—	68.0	1,135	31	—	771
Honey,	—	—	75.0	455	—	—	341
Corn starch,	—	—	98.0	500	—	—	490
Total,	—	—	—	65,180	4,480	1,017	53,356
Vegetables.							
Beans, dried,	22.3	1.8	59.1	1,950	435	35	1,152
Cabbage, edible portion,	2.1	.4	5.8	1,045	22	4	60
Onions,	1.5	.4	8.9	1,045	16	4	93
Potatoes, pared,	2.1	.1	18.0	52,165	1,095	52	9,390
Sweet potatoes,	1.5	.6	23.1	3,630	54	22	839
Squash, edible portion,	1.6	.6	10.3	5,170	83	31	532
Tomatoes, fresh,	.8	.4	3.9	2,450	20	10	95
Turnips,	1.0	.1	6.1	7,530	75	8	459
Total,	—	—	—	74,985	1,800	166	12,620
Fruits, Nuts, Etc.							
Apples, pared,	.5	.5	16.6	71,670	358	358	11,897
Blackberries, canned,	.8	2.1	56.4	1,540	12	32	869
Cranberries,	.5	.7	10.1	1,270	6	9	128
Currants, canned,	.8	2.1	56.4	770	6	16	435
Raisins,	2.5	4.7	74.7	455	11	21	340
Total,	—	—	—	75,705	393	436	13,669
Total vegetable food,	—	—	—	215,870	6,673	1,619	79,645
Total food,	—	—	—	331,230	17,277	20,972	82,345
Table and kitchen waste,	16.6	21.3	53.9	12,475	2,071	2,657	6,724

TABLE 52.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of a Farmer's Family in Connecticut.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.			
		Nutrients.				Nutrients.		
	Food Material.	Protein.	Fat.	Carbo-hydrates.	Food Material.	Protein.	Fat.	Carbo-hydrates.
For Family, 28 Days.	Grams.	Grams.	Grams.	Grams.	Lbs.	Lbs.	Lbs.	Lbs.
Beef, veal and mutton,	26,630	4,921	3,515	6	58.7	10.9	7.8	—
Pork, lard, etc., -	16,690	1,679	8,809	18	36.8	3.7	19.4	—
Poultry, - - -	6,305	933	69	—	13.9	2.1	.2	—
Fish, etc., - -	6,220	922	63	5	13.7	2.0	.1	—
Eggs, - - -	1,725	226	164	—	3.8	.5	.4	—
Butter, - - -	2,315	—	1,907	—	5.1	—	4.2	—
Cheese, - - -	1,225	319	419	28	2.7	.7	.9	.1
Milk and cream, -	54,250	1,604	4,407	2,643	119.6	3.5	9.7	5.9
Total animal food, -	115,360	10,604	19,353	2,700	254.3	23.4	42.7	6.0
Cereals, sugar, starch,	65,180	4,480	1,017	53,356	143.7	9.9	2.2	117.6
Vegetables, - -	74,985	1,800	166	12,620	165.3	4.0	.4	27.8
Fruits, - - -	75,705	393	436	13,669	166.9	.8	1.0	30.2
Total vegetable food,	215,870	6,673	1,619	79,645	475.9	14.7	3.6	175.6
Total food, - -	331,230	17,277	20,972	82,345	730.2	38.1	46.3	181.6
Per Man per Day.								
Beef, veal and mutton,	177	33	23	—	.39	.07	.05	—
Pork, lard, etc., -	111	11	58	—	.24	.02	.13	—
Poultry, - - -	42	6	1	—	.09	.01	—	—
Fish, etc., - -	41	6	—	—	.09	.01	—	—
Eggs, - - -	11	1	1	—	.02	—	—	—
Butter, - - -	15	—	13	—	.03	—	.03	—
Cheese, - - -	8	2	3	—	.02	.01	.01	—
Milk and cream, -	359	11	29	18	.80	.03	.06	.04
Total animal food, -	764	70	128	18	1.68	.15	.28	.04
Cereals, sugar, starch,	432	30	7	353	.95	.07	.02	.78
Vegetables, - -	497	12	1	84	1.10	.03	—	.18
Fruits, - - -	501	2	3	90	1.11	—	.01	.20
Total vegetable food,	1,430	44	11	527	3.16	.10	.03	1.16
Total food, - -	2,194	114	139	545	4.84	.25	.31	1.20
Percentages Total Food.	%	%	%	%				
Beef, veal and mutton,	8.0	28.5	16.8	—	—	—	—	—
Pork, lard, etc., -	5.0	9.7	42.0	—	—	—	—	—
Poultry, - - -	1.9	5.4	.3	—	—	—	—	—
Fish, etc., - -	1.9	5.4	.3	—	—	—	—	—
Eggs, - - -	.5	1.3	.8	—	—	—	—	—
Butter, - - -	.7	—	9.1	—	—	—	—	—
Cheese, - - -	.4	1.8	2.0	.1	—	—	—	—
Milk and cream, -	16.4	9.3	21.0	3.2	—	—	—	—
Total animal food, -	34.8	61.4	92.3	3.3	—	—	—	—
Cereals, sugar, starch,	19.7	25.9	4.8	64.8	—	—	—	—
Vegetables, - -	22.6	10.4	.8	15.3	—	—	—	—
Fruits, - - -	22.9	2.3	2.1	16.6	—	—	—	—
Total vegetable food,	65.2	38.6	7.7	96.7	—	—	—	—
Total food, - -	100.0	100.0	100.0	100.0	—	—	—	—

TABLE 53.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of a Farmer's Family in Connecticut.

Food Materials.		Nutrients. Protein.	Fat.	Carbohydrates.	Fuel Value.
For Family, 28 Days.		Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	10,604	19,353	2,700	234,530
	Vegetable,	6,673	1,619	79,645	368,960
	Total,	17,277	20,972	82,345	603,490
Waste,	Animal,	1,508	2,521	—	29,630
	Vegetable,	563	136	6,724	31,140
	Total,	2,071	2,657	6,724	60,770
Food actually eaten,	Animal,	9,096	16,832	2,700	204,900
	Vegetable,	6,110	1,483	72,921	337,820
	Total,	15,206	18,315	75,621	542,720
Per Man per Day.					
Food purchased,	Animal,	70	128	18	1,550
	Vegetable,	44	11	527	2,445
	Total,	114	139	545	3,995
Waste,	Animal,	10	17	—	200
	Vegetable,	4	1	44	205
	Total,	14	18	44	405
Food actually eaten,	Animal,	60	111	18	1,350
	Vegetable,	40	10	483	2,240
	Total,	100	121	501	3,590
Percentages of Total Food Purchased.		%	%	%	%
Food purchased,	Animal,	61.4	92.3	3.3	38.9
	Vegetable,	38.6	7.7	96.7	61.1
	Total,	100.0	100.0	100.0	100.0
Waste,	Animal,	8.7	12.0	—	4.9
	Vegetable,	3.3	.7	8.2	5.2
	Total,	12.0	12.7	8.2	10.1
Food actually eaten,	Animal,	52.7	80.3	3.3	34.0
	Vegetable,	35.3	7.0	88.5	55.9
	Total,	88.0	87.3	91.8	89.9

No. 121. DIETARY OF A FARMER'S FAMILY IN CONNECTICUT.

The study began October 16, 1895, and continued 28 days. The family consisted of a man about 40 years old, his wife about 35 years old, and his two sisters about 42 and 35 years of age. The number of meals taken were:

Man,	82 meals.
Women (244 x .9), equivalent to	195 meals.
Total number of meals taken equivalent to	277 meals.

Equivalent to one man 92 days.

Remarks.—The man rented his farm, and at the time of the dietary did about two days' work per week. The women had light exercise. With the exception of the wife all were below the average weight. The health of all was fair.

TABLE 54.

Food Materials and Table and Kitchen Wastes in Dietary of a Farmer's Family in Connecticut.

Food Materials.	Percentage Composition.			Weight Used.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
Animal Food.	%	%	%	Grams.	Grams.	Grams.	Grams.
Beef.							
Sirloin,	15.9	17.6	—	1,815	289	319	—
Socket,	10.7	16.2	—	2,720	291	441	—
Roast, canned,	25.0	14.8	—	905	226	134	—
Corned, cooked & canned,	28.5	14.0	—	455	129	64	—
Dried and smoked,	31.8	6.8	.6	455	144	31	3
Total,	—	—	—	6,350	1,079	989	3
Lamb.							
Chops,	15.0	24.1	—	500	75	120	—
Pork.							
Loin,	14.1	25.6	—	4,715	665	1,207	—
Steak,	10.7	10.6	—	680	73	72	—
Ham, lean, smoked,	17.9	18.5	—	4,445	796	822	—
Lard,	—	100.0	—	1,725	—	1,725	—
Total,	—	—	—	11,565	1,534	3,826	—
Fish, Etc.							
Cod, fresh,	10.6	.2	—	545	58	1	—
Mackerel, fresh,	11.4	3.5	—	410	47	14	—
Halibut, fresh,	15.1	4.4	—	905	136	40	—
Total,	—	—	—	1,860	241	55	—
Eggs,	13.1	9.5	—	680	89	65	—
Butter,	—	82.4	—	4,615	—	3,803	—
Cheese,	26.0	34.2	2.3	955	248	327	22
Milk, whole *(a)*,	3.4	4.3	5.0	23,815	810	1,024	1,191
Milk, skim *(a)*,	4.1	.6	5.2	6,625	272	40	344
Total animal food,	—	—	—	56,965	4,348	10,249	1,560

TABLE 54.—*(Continued.)*

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			WEIGHT USED.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
VEGETABLE FOOD.	%	%	%	Grams.	Grams.	Grams.	Grams.
Cereals, Sugar, Etc.							
Flour, entire wheat, -	14.2	1.9	70.6	4,080	597	78	2,880
Flour, pastry, - -	10.4	1.0	75.6	14,740	1,533	147	11,144
Cookies, sugar, - -	6.8	8.9	75.3	455	31	40	340
Sugar, granulated, -	—	—	100.0	5,340	—	—	5,340
Molasses, - - -	2.7	—	68.0	1,950	52	—	1,327
Total, - - -	—	—	—	26,565	2,195	265	21,031
Vegetables.							
Onions, edible portion, -	1.7	.4	9.9	3,265	56	13	323
Potatoes, pared, - -	2.1	.1	18.0	20,640	433	21	3,715
Sweet potatoes, pared, -	1.8	.7	27.1	7,260	131	51	1,967
Total, - - -	—	—	—	31,165	620	85	6,005
Fruits, Nuts, Etc.							
Apples, flesh, - -	.5	.5	16.6	22,680	113	113	3,765
Raisins, - - -	2.5	4.7	74.7	225	5	11	168
Total, - - -	—	—	—	22,905	118	124	3,933
Total vegetable food, -	—	—	—	80,635	2,933	474	30,969
Total food, - - -	—	—	—	137,600	7,281	10,723	32,529

TABLE 55.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of a Farmer's Family in Connecticut.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.			
	Food Material.	Nutrients.			Food Material.	Nutrients.		
		Protein.	Fat.	Carbohydrates.		Protein.	Fat.	Carbohydrates.
For Family, 28 Days.	Grams.	Grams.	Grams.	Grams.	Lbs.	Lbs.	Lbs.	Lbs.
Beef, veal and mutton, -	6,850	1,154	1,109	3	15.1	2.6	2.5	—
Pork, lard, etc., - -	11,565	1,534	3,826	—	25.5	3.4	8.4	—
Fish, etc., - - -	1,860	241	55	—	4.1	.5	.1	—
Eggs, - - - -	680	89	65	—	1.5	.2	.1	—
Butter, - - -	4,615	—	3,803	—	10.2	—	8.4	—
Cheese, - - -	955	248	327	22	2.1	.5	.7	.1
Milk, - - - -	30,440	1,082	1,064	1,535	67.1	2.4	2.4	3.3
Total animal food, -	56,965	4,348	10,249	1,560	125.6	9.6	22.6	3.4
Cereals, sugar, starch, -	26,565	2,195	265	21,031	58.6	4.8	.6	46.4
Vegetables, - - -	31,165	620	85	6,005	68.7	1.4	.2	13.2
Fruits, - - -	22,905	118	124	3,933	50.5	.3	.3	8.7
Total vegetable food,	80,635	2,933	474	30,969	177.8	6.5	1.1	68.3
Total food, - -	137,600	7,281	10,723	32,529	303.4	16.1	23.7	71.7
Per Man per Day.								
Beef, veal and mutton, -	75	12	12	—	.17	.03	.03	—
Pork, lard, etc., - -	126	17	42	—	.28	.04	.09	—
Fish, etc., - - -	20	2	1	—	.04	—	—	—
Eggs, - - - -	7	1	1	—	.02	—	—	—
Butter, - - -	50	—	41	—	.11	—	.09	—
Cheese, - - -	10	3	3	—	.02	.01	.01	—
Milk, - - - -	331	12	12	17	.73	.02	.03	.04
Total animal food, -	619	47	112	17	1.37	.10	.25	.04
Cereals, sugar, starch, -	289	24	3	229	.63	.05	.01	.51
Vegetables, - - -	339	7	1	65	.75	.02	—	.14
Fruits, - - -	249	1	1	43	.55	—	—	.09
Total vegetable food,	877	32	5	337	1.93	.07	.01	.74
Total food, - -	1,496	79	117	354	3.30	.17	.26	.78
Percentages Total Food.	%	%	%	%				
Beef, veal and mutton, -	5.0	15.8	10.3	—	—	—	—	—
Pork, lard, etc., - -	8.4	21.1	35.7	—	—	—	—	—
Fish, etc., - - -	1.3	3.3	.5	—	—	—	—	—
Eggs, - - - -	.5	1.2	.6	—	—	—	—	—
Butter, - - -	3.4	—	35.5	—	—	—	—	—
Cheese, - - -	.7	3.4	3.1	.1	—	—	—	—
Milk, - - - -	22.1	14.9	9.9	4.7	—	—	—	—
Total animal food, -	41.4	59.7	95.6	4.8	—	—	—	—
Cereals, sugar, starch, -	19.3	30.2	2.5	64.7	—	—	—	—
Vegetables, - - -	22.7	8.5	.8	18.4	—	—	—	—
Fruits, - - -	16.6	1.6	1.1	12.1	—	—	—	—
Total vegetable food,	58.6	40.3	4.4	95.2	—	—	—	—
Total food, - -	100.0	100.0	100.0	100.0	—	—	—	—

TABLE 56.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of a Farmer's Family in Connecticut.

Food Materials.		Nutrients.			Fuel Value.
		Protein.	Fat.	Carbohydrates.	
For Family, 28 Days.		Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	4,348	10,249	1,560	119,540
	Vegetable,	2,933	474	30,969	143,405
	Total,	7,281	10,723	32,529	262,945
Food actually eaten,*	Animal,	4,348	10,249	1,560	119,540
	Vegetable,	2,933	474	30,969	143,405
	Total,	7,281	10,723	32,529	262,945
Per Man per Day.					
Food purchased,	Animal,	47	112	17	1,305
	Vegetable,	32	5	337	1,560
	Total,	79	117	354	2,865
Food actually eaten,	Animal,	47	112	17	1,305
	Vegetable,	32	5	337	1,560
	Total,	79	117	354	2,865
Percentages of Total Food Purchased.		%	%	%	%
Food purchased,	Animal,	59.7	95.6	4.8	45.5
	Vegetable,	40.3	4.4	95.2	54.5
	Total,	100.0	100.0	100.0	100.0
Food actually eaten,	Animal,	59.7	95.6	4.8	45.5
	Vegetable,	40.3	4.4	95.2	54.5
	Total,	100.0	100.0	100.0	100.0

* No "waste" in this dietary.

No. 123. DIETARY OF A FARMER'S FAMILY IN CONNECTICUT.

The study began December 6, 1895, and continued 18 days. The members of the family and number of meals taken were as follows:

Man, 45 years old,	52 meals.
Woman, 41 years old (54 x .8), equivalent to	43 meals.
Girl, 13 years old (53 x .6), equivalent to	32 meals.
Girl, 10 years old (52 x .6), equivalent to	31 meals.
Boy, 8 years old (54 x .5), equivalent to	27 meals.
Girl, 4 years old (54 x .4), equivalent to	22 meals.
Girl, 9 months old (54 x .3), equivalent to	16 meals.
Girl, boarder, 19 years old (43 x .8), equivalent to	34 meals.
Man, boarder,	54 meals.
Man, workman, 21 years old,	47 meals.
Visitor, man,	15 meals.
Visitor, woman (5 x .8), equivalent to	4 meals.
Total number of meals taken equivalent to	377 meals.

Equivalent to one man 126 days.

TABLE 57.

Food Materials and Table and Kitchen Wastes in Dietary of a Farmer's Family in Connecticut.

Food Materials.	Percentage Composition.			Weight Used.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
Animal Food.	%	%	%	Grams.	Grams.	Grams.	Grams.
Beef.							
Hind quarter,	14.9	17.5	—	51,255	7,637	8,970	—
Corned,	11.4	35.8	—	5,170	589	1,851	—
Corned, cooked,	28.5	14.0	—	410	117	57	—
Dried,	31.8	6.8	.6	635	202	43	4
Total,	—	—	—	57,470	8,545	10,921	4
Left at Close.							
Loin with tallow,	15.8	24.0	—	13,825	2,184	3,318	—
Shank, to round,	14.0	5.8	—	13,155	1,842	763	—
Total,	—	—	—	26,980	4,026	4,081	—
Total used,	—	—	—	30,490	4,519	6,840	4
Pork.							
Ham,	13.3	33.4	—	2,585	344	863	—
Salt,	1.8	87.2	—	1,495	27	1,304	—
Heart,	17.6	6.3	—	590	104	37	—
Liver,	21.3	4.5	1.4	1,815	387	82	25
Lungs,	11.8	4.0	—	455	54	18	—
Lard,	—	100.0	—	2,625	—	2,625	—
Sausage,	12.8	45.4	.8	3,855	493	1,750	31
Total,	—	—	—	13,420	1,409	6,679	56
Poultry.							
Chicken,	14.8	1.1	—	5,670	839	62	—
Fish, Etc.							
Oysters in shell,	1.2	.2	.7	7,125	86	14	50

TABLE 57.—*(Continued.)*

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			WEIGHT USED.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
ANIMAL FOOD.—*(Con.)*	%	%	%	Grams.	Grams.	Grams.	Grams.
Eggs,	13.1	9.5	—	2,085	273	198	—
Butter,	—	82.4	—	3,585	—	2,954	—
Milk *(a*)*,	3.1	3.8	4.8	50,170	1,555	1,907	2,408
Milk, skim *(a*)*,	3.4	.4	5.1	37,285	1,268	149	1,901
Cream,	2.5	18.5	4.5	6,940	174	1,284	312
Total animal food,	—	—	—	156,770	10,123	20,087	4,731
VEGETABLE FOOD. *Cereals, Sugar, Etc.*							
Buckwheat flour *(a)*,	5.1	.9	81.6	680	35	6	555
Corn meal *(a)*,	10.1	5.3	72.4	10,615	1,072	562	7,685
Rice,	7.8	.4	79.0	320	25	1	253
Rolled oats *(a)*,	16.5	6.6	67.9	1,995	329	132	1,354
Rye bran *(a)*,	10.7	1.6	74.3	2,450	262	39	1,821
Rye middlings *(a)*,	7.9	.5	75.4	1,270	100	6	958
Rye flour *(a)*,	4.9	.2	80.2	3,540	173	7	2,839
Wheat flour, bread *(a)*,	12.7	.8	74.4	14,330	1,820	115	1,066
Wheat flour, pastry *(a)*,	11.2	.8	76.9	9,740	1,091	78	7,490
Bread, wheat,	9.5	1.2	52.8	3,220	306	39	1,700
Bread, brown,	5.0	2.4	50.7	3,855	193	93	1,954
Bread, rye,	10.1	.7	55.9	500	50	4	280
Crackers,	9.3	13.1	69.2	1,680	157	220	1,162
Chocolate,	12.5	47.1	26.8	270	34	127	72
Cocoanut, shredded,	6.3	57.4	31.5	45	3	26	14
Sugar, granulated,	—	—	100.0	365	—	—	365
Sugar, coffee,	—	—	95.0	4,810	—	—	4,570
Molasses,	2.7	—	68.0	4,080	110	—	2,774
Total,	—	—	—	63,765	5,760	1,455	36,912
Vegetables.							
Beans, dried,	22.3	1.8	59.1	2,270	506	41	1,342
Cabbage, cooked,	2.1	.4	5.8	725	15	3	42
Cabbage, raw,	1.8	.3	4.9	2,585	47	8	126
Onions,	1.5	.4	8.9	1,270	19	5	113
Pickles,	.5	.5	5.4	1,815	9	9	98
Potatoes,	1.8	.1	15.3	41,275	743	41	6,315
Squash,	.8	.3	5.2	13,290	106	40	691
Turnips,	1.0	.1	6.1	7,030	70	7	429
Total,	—	—	—	70,260	1,515	154	9,156
Fruits, Nuts, Etc.							
Apples,	.4	.4	12.4	35,150	141	141	4,358
Grapes, raspberries, canned	.8	2.1	56.4	3,130	25	66	1,765
Pears,	.5	.2	5.3	3,720	19	7	197
Raisins,	2.5	4.7	74.7	365	9	17	273
Total,	—	—	—	42,365	194	231	6,593
Total vegetable food,	—	—	—	176,390	7,469	1,840	52,661
Total food,	—	—	—	333,160	17,592	21,927	57,392
Table and kitchen waste,	23.1	12.5	56 9	5,115	1,182	639	2,910
Clear fat,	—	100.0	—	1,000	—	1,000	—
Total,	—	—	—	6,115	1,182	1,639	2,910

* Only fat determined.

TABLE 58.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of a Farmer's Family in Connecticut.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.			
	Food Material.	Nutrients.			Food Material.	Nutrients.		
		Protein.	Fat.	Carbohydrates.		Protein.	Fat.	Carbohydrates.
For Family, 18 Days.	Grams.	Grams.	Grams.	Grams.	Lbs.	Lbs.	Lbs.	Lbs.
Beef, veal and mutton,	30,490	4,519	6,840	4	67.2	10.0	15.1	—
Pork, lard, etc., - -	13,420	1,409	6,679	56	29.6	3.1	14.7	.1
Poultry, - - -	5,670	839	62	—	12.5	1.8	.2	—
Fish, etc., - - -	7,125	86	14	50	15.7	.2	—	.1
Eggs, - - -	2,085	273	198	—	4.6	.6	.5	—
Butter, - - -	3,585	—	2,954	—	7.9	—	6.5	—
Milk, - - -	50,170	1,555	1,907	2,408	110.6	3.4	4.2	5.3
Milk, skim, - -	37,285	1,268	149	1,901	82.2	2.8	.3	4.2
Cream, - - -	6,940	174	1,284	312	15.3	.4	2.8	.7
Total animal food, -	156,770	10,123	20,087	4,731	345.6	22.3	44.3	10.4
Cereals, sugar, starch,	63,765	5,760	1,455	36,912	140.6	12.7	3.2	81.4
Vegetables, - -	70,260	1,515	154	9,156	154.9	3.4	.3	20.2
Fruits, - - -	42,365	194	231	6,593	93.4	.4	.5	14.5
Total vegetable food,	176,390	7,469	1,840	52,661	388.9	16.5	4.0	116.1
Total food, - -	333,160	17,592	21,927	57,392	734.5	38.8	48.3	126.5
Per Man per Day.								
Beef, veal and mutton,	242	36	54	—	.53	.08	.12	—
Pork, lard, etc., - -	107	11	53	1	.24	.02	.12	—
Poultry, - - -	45	7	1	—	.10	.02	—	—
Fish, etc., - - -	56	1	—	—	.12	—	—	—
Eggs, - - -	17	2	2	—	.04	.01	.01	—
Butter, - - -	28	—	23	—	.06	—	.05	—
Milk, - - -	398	12	15	19	.88	.03	.03	.04
Milk, skim, - -	296	10	1	15	.65	.02	—	.03
Cream, - - -	55	1	10	3	.12	—	.02	.01
Total animal food, -	1,244	80	159	38	2.74	.18	.35	.08
Cereals, sugar, starch,	506	46	12	293	1.12	.10	.03	.65
Vegetables, - -	558	12	1	73	1.23	.03	—	.16
Fruits, - - -	336	2	2	52	.74	—	—	.11
Total vegetable food,	1,400	60	15	418	3.09	.13	.03	.92
Total food, - -	2,644	140	174	456	5.83	.31	.38	1.00
Percentages Total Food.	%	%	%	%				
Beef, veal and mutton,	9.2	25.7	31.2	—	—	—	—	—
Pork, lard, etc., - -	4.0	8.0	30.5	.1	—	—	—	—
Poultry, - - -	1.7	4.8	.3	—	—	—	—	—
Fish, etc., - - -	2.1	.5	—	.1	—	—	—	—
Eggs, - - -	.6	1.5	.9	—	—	—	—	—
Butter, - - -	1.1	—	13.5	—	—	—	—	—
Milk, - - -	15.1	8.8	8.7	4.2	—	—	—	—
Milk, skim, - -	11.2	7.2	.7	3.3	—	—	—	—
Cream, - - -	2.1	1.0	5.8	.5	—	—	—	—
Total animal food, -	47.1	57.5	91.6	8.2	—	—	—	—
Cereals, sugar, starch,	19.1	32.8	6.6	64.3	—	—	—	—
Vegetables, - -	21.1	8.6	.7	16.0	—	—	—	—
Fruits, - - -	12.7	1.1	1.1	11.5	—	—	—	—
Total vegetable food,	52.9	42.5	8.4	91.8	—	—	—	—
Total food, - -	100.0	100.0	100.0	100.0	—	—	—	—

TABLE 59.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of a Farmer's Family in Connecticut.

Food Materials.		Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
For Family, 18 Days.		Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	10,123	20,087	4,731	247,710
	Vegetable,	7,469	1,840	52,661	263,640
	Total,	17,592	21,927	57,392	511,350
Waste,	Animal,	769	1,537	—	17,450
	Vegetable,	413	102	2,910	14,570
	Total,	1,182	1,639	2,910	32,020
Food actually eaten,	Animal,	9,354	18,550	4,731	230,260
	Vegetable,	7,056	1,738	49,751	249,070
	Total,	16,410	20,288	54,482	479,330
Per Man per Day.					
Food purchased,	Animal,	80	159	38	1,960
	Vegetable,	60	15	418	2,100
	Total,	140	174	456	4,060
Waste,	Animal,	6	12	—	135
	Vegetable,	3	1	23	115
	Total,	9	13	23	250
Food actually eaten,	Animal,	74	147	38	1,825
	Vegetable,	57	14	395	1,985
	Total,	131	161	433	3,810
Percentages of Total Food Purchased.		%	%	%	%
Food purchased,	Animal,	57.5	91.6	8.2	48.5
	Vegetable,	42.5	8.4	91.8	51.5
	Total,	100.0	100.0	100.0	100.0
Waste,	Animal,	4.4	7.0	—	3.4
	Vegetable,	2.3	.5	5.1	2.9
	Total,	6.7	7.5	5.1	6.3
Food actually eaten,	Animal,	53.1	84.6	8.2	45.1
	Vegetable,	40.2	7.9	86.7	48.6
	Total,	93.3	92.5	94.9	93.7

No. 124. DIETARY OF COLLEGE STUDENTS IN CONNECTICUT.

The study began November 11, 1895, and continued 15 days. The number of meals taken were as follows:

Men,	2,825 meals.
Women (624 x .8), equivalent to	499 meals.
Total number of meals taken equivalent to	3,324 meals.

Equivalent to one man 1,108 days.

TABLE 60.

Food Materials and Table and Kitchen Wastes in Dietary of College Students in Connecticut.

Food Materials.	Percentage Composition.			Weight Used.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
Animal Food.	%	%	%	Grams.	Grams.	Grams.	Grams.
Beef.							
Neck and shoulder,	15.7	10.2	—	16,965	2,664	1,730	—
Rib roast,	13.4	21.3	—	14,740	1,975	3,140	—
Shoulder clod,	19.3	11.3	—	4,900	946	554	—
Fore quarter, m'd'm fat,	14.1	17.3	—	59,650	8,410	10,319	—
Hind quarter, m'd'm fat,	14.9	17.5	—	153,770	22,912	26,911	—
Hind quarter, m'd'm fat,	14.4	26.9	—	73,710	10,614	19,828	—
Dried and smoked,	31.8	6.8	.6	15,560	4,948	1,058	93
Corned,	14.2	22.8	—	41,960	5,958	9,567	—
Total,	—	—	—	381,255	58,427	73,107	93
Beef Left.							
Flank,	17.2	20.7	—	4,310	741	892	—
Fore leg,	12.3	7.3	—	8,620	1,060	629	—
Hind leg,	9.1	5.3	—	11,340	1,032	601	—
Plate,	11.4	35.8	—	27,985	3,190	10,019	—
Porterhouse steak,	15.9	17.6	—	770	122	136	—
Rump,	13,2	20.2	—	6,895	910	1,393	—
Corned flank, fat,	12.4	29.2	—	3,175	394	927	—
Total,	—	—	—	63,095	7,449	14,597	—
Total beef used,	—	—	—	318,160	50,978	58,510	93
Pork.							
Fresh ham,	10.7	10.6	—	19,280	2,063	2,044	—
Head,	3.8	13.9	—	5,895	224	819	—
Ham, smoked,	13.3	33.4	—	14,695	1,954	4,908	—
Shoulder, smoked,	12.9	26.6	—	15,875	2,048	4,223	—
Bacon,	9.2	61.8	—	10,660	981	6,588	—
Salt flank,	6.5	59.6	—	3,400	221	2,026	—
Lard,	—	100.0	—	26,855	—	26,855	—
Total,	—	—	—	96,660	7,491	47,463	—

TABLE 60.—*(Continued.)*

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			WEIGHT USED.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
ANIMAL FOOD.	%	%	%	Grams.	Grams.	Grams.	Grams.
Fish, Etc.							
Haddock, dressed, -	8.2	.2	—	40,370	3,310	81	—
Cod, salt, - - -	16.0	.4	—	7,215	1,154	29	—
Oysters, " solids," -	6.1	1.4	3.3	26,220	1,600	367	865
Total, - - -	—	—	—	73,805	6,064	477	865
Eggs, - - - -	13.1	9.5	—	8,255	1,082	784	—
Butter, - - -	—	82.4	—	71,395	—	58,829	—
Cheese, - - -	26.0	34.2	2.3	1,270	330	435	29
Milk (4.2 % fat), - -	3.3	4.2	5.0	631,820	20,850	26,536	31,591
Milk, skim, - - -	3.4	.3	5.1	324,640	11,038	974	16,556
Total animal food, -	—	—	—	1,526,005	97,833	194,008	49,134
VEGETABLE FOOD.							
Cereals, Sugar, Etc.							
Corn meal, - - -	8.9	2.2	75.1	11,205	997	247	8,415
Farina, - - -	11.1	1.4	77.6	2,040	226	29	1,583
Flour, bread, - -	11.3	1.1	74.6	198,755	22,460	2,186	148,271
Flour, pastry, - -	10.4	1.0	75.6	45,265	4,708	453	34,220
Flour, graham, - -	13.7	2.2	70.3	14,305	1,960	315	10,056
Oat meal, - - -	15.6	7.3	68.0	28,410	4,432	2,074	19,319
Rice, - - - -	7.8	.4	79.0	8,390	654	34	6,628
Bread, - - - -	9.5	1.2	52.8	5,580	2,946	67	530
Crackers, milk, - -	9.3	13.1	69.2	16,105	1,498	2,110	11,144
Crackers, soda, - -	10.3	9.4	70.5	9,525	981	896	6,715
Crackers, oyster, - -	11.0	8.8	74.2	8,935	983	786	6,630
Macaroni, - - -	11.7	1.6	72.9	2,220	260	36	1,618
Frosted cake, - -	6.2	9.4	64.3	2,220	138	209	1,427
Sugar, granulated, -	—	—	100.0	128,235	—	—	128,235
Sugar, coffee, - -	—	—	95.0	46,405	—	—	44,085
Syrup, - - - -	—	—	72.0	61,915	—	—	44,579
Molasses, - - -	2.7	—	68.0	4,990	135	—	3,393
Honey, - - -	—	—	75.0	455	—	—	341
Corn starch, - -	—	—	98.0	2,495	—	—	2,445
Chocolate, - - -	12.5	47.1	26.8	1,800	225	848	482
Total, - - -	—	—	—	599,250	42,603	10,290	480,116
Vegetables.							
Beans, dried, - -	22.3	1.8	59.1	14,970	3,338	270	8,847
Beets, - - - -	1.3	.1	7.7	21,820	284	22	1,680
Citron, dried, - -	.4	.6	72.5	1,000	4	6	725
Cabbage, - - -	1.8	.3	4.9	7,390	133	22	362
Onions, - - -	1.5	.4	8.9	32,385	486	130	2,982
Potatoes (39.6 % refuse),	2.1	.1	18.0	240,500	5,050	241	43,290

TABLE 60.—*(Continued.)*

FOOD MATERIALS.	PERCENTAGE COMPOSITION.			WEIGHT USED.			
					Nutrients.		
	Protein.	Fat.	Carbohydrates.	Total Food Material.	Protein.	Fat.	Carbohydrates.
VEGETABLE FOOD.	%	%	%	Grams.	Grams.	Grams.	Grams.
Vegetables.—(Con.)							
Potatoes, whole,	1.8	.1	15.3	54,295	978	54	8,307
Sweet potatoes (10.4 % refuse),	1.8	.7	27.1	18,825	339	132	5,101
Squash,	.8	.3	5.2	26,900	215	81	1,399
Tomatoes, canned,	1.2	.2	4.0	13,880	167	28	555
Turnips, edible portion,	1.4	.2	8.7	12,700	178	25	1,105
Total,	—	—	—	444,665	11,172	1,011	74,353
Fruits, Nuts, Etc.							
Apples,	.4	.4	12.4	36,515	146	146	4,528
Apple sauce,	.5	.5	16.6	8,345	42	42	1,469
Cranberries,	.5	.7	10.1	9,345	47	65	1,044
Currants, dried,	1.2	3.0	65.7	1,590	19	48	1,044
Grape preserves,*	.8	2.1	56.4	2,965	24	62	1,672
Quinces, canned,*	.3	2.4	54.4	3,085	9	74	1,678
Peaches, canned,	.5	.2	5.3	3,990	20	8	211
Raisins,	2.5	4.7	74.7	2,720	68	128	2,032
Total,	—	—	—	68,555	375	573	13,678
Total vegetable food,	—	—	—	1,112,470	54,150	11,874	568,147
Total food,	—	—	—	2,638,475	151,983	205,882	617,281
Table and Kitchen Waste.							
Skim milk,	3.4	.3	5.1	277,600	9,438	833	14,158
Other waste,	22.1	27.1	45.7	120,795	26,695	32,736	55,203
Total,	—	—	—	398,395	36,133	33,569	69,361

* Composition assumed.

TABLE 61.

Weights and Percentages of Food Materials and Nutritive Ingredients Used in Dietary of College Students in Connecticut.

FOOD MATERIALS.	WEIGHT IN GRAMS.				WEIGHT IN POUNDS.			
	Food Material.	Nutrients.			Food Material.	Nutrients.		
		Protein.	Fat.	Carbo-hydrates.		Protein.	Fat.	Carbo-hydrates.
For Family, 15 Days.	Grams.	Grams.	Grams.	Grams.	Lbs.	Lbs.	Lbs.	Lbs.
Beef, veal and mutton,	318,160	50,978	58,510	93	701.4	112.4	129.0	.2
Pork, lard, etc., -	96,660	7,491	47,463	—	213.1	16.5	104.6	—
Fish, etc., - -	73,805	6,064	477	865	162.7	13.4	1.1	1.9
Eggs, - - -	8,255	1,082	784	—	18.2	2.4	1.7	—
Butter, - - -	71,395	—	58,829	—	157.4	—	129.7	—
Cheese, - - -	1,270	330	435	29	2.8	.7	1.0	.1
Milk, - - -	631,820	20,850	26,536	31,591	1,392.9	46.0	58.5	69.6
Milk, skim, - -	324,640	11,038	974	16,556	715.7	24.3	2.1	36.5
Total animal food, -	1,526,005	97,833	194,008	49,134	3,364.2	215.7	427.7	108.3
Cereals, sugar, starch,	599,250	42,603	10,290	480,116	1,321.1	93.9	22.7	1,058.4
Vegetables, - -	444,665	11,172	1,011	74,353	980.3	24.7	2.3	163.9
Fruits, - - -	68,555	375	573	13,678	151.1	.8	1.2	30.2
Total vegetable food,	1,112,470	54,150	11,874	568,147	2,452.5	119.4	26.2	1,252.5
Total food, - -	2,638,475	151,983	205,882	617,281	5,816.7	335.1	453.9	1,360.8
Per Man per Day.								
Beef, veal and mutton,	287	46	53	—	.63	.10	.12	—
Pork, lard, etc., -	87	7	43	—	.19	.02	.10	—
Fish, etc., - -	67	5	—	1	.15	.01	—	—
Eggs, - - -	8	1	1	—	.02	—	—	—
Butter, - - -	64	—	53	—	.14	—	.12	—
Cheese, - - -	1	—	—	—	—	—	—	—
Milk, - - -	570	19	24	28	1.26	.04	.05	.06
Milk, skim, - -	293	10	1	15	.65	.02	—	.04
Total animal food, -	1,377	88	175	44	3.04	.19	.39	.10
Cereals, sugar, starch,	541	39	9	434	1.19	.09	.02	.96
Vegetables, - -	401	10	1	67	.88	.02	—	.15
Fruits, - - -	62	—	1	12	.14	—	—	.02
Total vegetable food,	1,004	49	11	513	2.21	.11	.02	1.13
Total food, - -	2,381	137	186	557	5.25	.30	.41	1.23
Percentages Total Food.	%	%	%	%				
Beef, veal and mutton,	12.1	33.6	28.4	—	—	—	—	—
Pork, lard, etc., -	3.7	4.9	23.0	—	—	—	—	—
Fish, etc., - -	2.8	4.0	.2	.2	—	—	—	—
Eggs, - - -	.3	.7	.4	—	—	—	—	—
Butter, - - -	2.7	—	28.6	—	—	—	—	—
Cheese, - - -	—	.2	.2	—	—	—	—	—
Milk, - - -	23.9	13.7	12.9	5.1	—	—	—	—
Milk, skim, - -	12.3	7.3	.5	2.7	—	—	—	—
Total animal food, -	57.8	64.4	94.2	8.0	—	—	—	—
Cereals, sugar, starch,	22.7	28.1	5.0	77.8	—	—	—	—
Vegetables, - -	16.9	7.3	.5	12.0	—	—	—	—
Fruits, - - -	2.6	.2	.3	2.2	—	—	—	—
Total vegetable food,	42.2	35.6	5.8	92.0	—	—	—	—
Total food, - -	100.0	100.0	100.0	100.0	—	—	—	—

TABLE 62.

Nutrients and Potential Energy in Food Purchased, Rejected and Eaten in Dietary of College Students in Connecticut.

FOOD MATERIALS.		NUTRIENTS.			FUEL VALUE.
		Protein.	Fat.	Carbohydrates.	
For Family, 15 Days.		Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	97,833	194,008	49,134	2,406,840
	Vegetable,	54,150	11,874	568,147	2,661,850
	Total,	151,983	205,882	617,281	5,068,690
Waste,	Animal,	30,872	32,415	14,158	486,080
	Vegetable,	5,261	1,154	55,203	258,640
	Total,	36,133	33,569	69,361	744,720
Food actually eaten,	Animal,	66,961	161,593	34,976	1,920,760
	Vegetable,	48,889	10,720	512,944	2,403,210
	Total,	115,850	172,313	547,920	4,323,970
Per Man per Day.					
Food purchased,	Animal,	88	175	44	2,170
	Vegetable,	49	11	513	2,405
	Total,	137	186	557	4,575
Waste,	Animal,	28	29	13	440
	Vegetable,	5	1	50	235
	Total,	33	30	63	675
Food actually eaten,	Animal,	60	146	31	1,730
	Vegetable,	44	10	463	2,170
	Total,	104	156	494	3,900
Percentages of Total Food Purchased.					
Food purchased,	Animal,	64.4	94.2	8.0	47.5
	Vegetable,	35.6	5.8	92.0	52.5
	Total,	100.0	100.0	100.0	100.0
Waste,	Animal,	20.3	15.7	2.3	9.6
	Vegetable,	3.5	.6	8.9	5.1
	Total,	23.8	16.3	11.2	14.7
Food actually eaten,	Animal,	44.1	78.5	5.7	37.9
	Vegetable,	32.1	5.2	83.1	47.4
	Total,	76.2	83.7	88.8	85.3

TABLE 63.

Summary of Results of Dietary Studies made by the Station. Food per Man per Day.

DIETARIES.	NUTRIENTS.			FUEL VALUE.
	Protein.	Fat.	Carbo-hydrates.	
	Grams.	Grams.	Grams.	Calories.
1. *Dietary of a Boarding House.**				
Food, Purchased,	126	188	426	4,010
Waste,	23	36	25	510
Eaten,	103	152	401	3,500
2. *Dietary of a Chemist's Family.**				
Food purchased, ‖	118	103	430	3,210
3. *Dietary of a Jeweler's Family.*†				
Food, Purchased,	91	126	483	3,530
Waste,	8	9	5	140
Eaten,	83	117	478	3,390
4. *Dietary of a Blacksmith's Family.*†				
Food, Purchased,	103	176	408	3,730
Waste,	3	5	7	90
Eaten,	100	171	401	3,640
5. *Dietary of a Machinist's Family.*†				
Food, Purchased,	100	159	427	3,640
Waste,	1	3	6	60
Eaten,	99	156	421	3,580
Two Dietaries of a Mason's Family.†				
6. December, 1892.				
Food, Purchased,	107	153	391	3,470
Waste,	3	5	16	120
Eaten,	104	148	375	3,350
10. May, 1893.‡				
Food, Purchased,	125	145	366	3,365
Waste,	6	8	18	175
Eaten,	119	137	348	3,190
Average of 6 and 10.				
Food, Purchased,	116	149	379	3,420
Waste,	5	6	17	150
Eaten,	111	143	362	3,270
7. *Dietary of a Carpenter's Family.*†				
Food, Purchased,	125	152	498	3,970
Waste,	11	17	23	300
Eaten,	114	135	475	3,670
Two Dietaries of a Carpenter's Family.				
8. November, 1892.†				
Food, Purchased,	107	161	408	3,610
Waste,	7	12	20	220
Eaten,	100	149	388	3,390

TABLE 63.—*(Continued.)*

DIETARIES.	NUTRIENTS.			FUEL VALUE.
	Protein.	Fat.	Carbo-hydrates.	
	Grams.	Grams.	Grams.	Calories.
11. May, 1893.‡				
Food, Purchased,	115	125	346	3,055
Food, Waste,	4	3	10	96
Food, Eaten,	111	122	336	2.965
Average of 8 and 11.				
Food, Purchased,	111	144	377	3,335
Food, Waste,	6	8	15	150
Food, Eaten,	105	136	362	3,185
Two Dietaries of Station Agriculturist's Family.‡				
9. Winter, 1893.				
Food, Purchased,	106	145	405	3,450
Food, Waste,	7	6	7	115
Food, Eaten,	99	139	398	3,335
13. Summer, 1893.				
Food, Purchased,	133	150	475	3,885
Food, Waste,	4	5	3	85
Food, Eaten,	129	145	472	3,800
Average of 9 and 13.				
Food, Purchased,	120	147	440	3,670
Food, Waste,	6	5	5	100
Food, Eaten,	114	142	435	3,570
12. *Dietary of a Student's Club.*‡				
Food, Purchased,	113	180	376	3,680
Food, Waste,	19	39	30	570
Food, Eaten,	94	141	346	3,110
14. *Dietary of a Widow's Family.*§				
Food, Purchased,	119	115	512	3,655
Food, Waste,	3	4	12	100
Food, Eaten,	116	111	500	3,555
Two Dietaries of a Swede Family.§				
15. March, 1894.				
Food, Purchased,	121	116	473	3,510
Food, Waste,	3	4	7	80
Food, Eaten,	118	112	466	3,430
19. November, 1894.				
Food, Purchased,	137	129	651	4,440
Food, Waste,	4	6	15	140
Food, Eaten,	133	123	636	4,300
Average of 15 and 19.				
Food, Purchased,	129	118	562	3,980
Food, Waste,	3	5	11	110
Food, Eaten,	126	113	551	3,870

TABLE 63.—*(Continued.)*

DIETARIES.	NUTRIENTS.			Fuel Value.
	Protein.	Fat.	Carbo-hydrates.	
	Grams.	Grams.	Grams.	Calories.
16. *Dietary of a College Club.*§				
Food, Purchased,	113	160	343	3,500
Waste,	9	24	17	330
Eaten,	104	136	326	3,170
17. *Dietary of a Divinity School Club.*§				
Food, Purchased,	139	185	356	3,745
Waste,	17	47	39	660
Eaten,	122	138	317	3,085
18. *Dietary of a College Ladies' Eating Club.*§				
Food, Purchased,	135	196	377	3,920
Waste,	30	36	47	650
Eaten,	105	160	330	3,270
20. *Dietary of Three Chemists.*§				
Food, Purchased,	122	177	483	4,130
Waste,	6	7	16	150
Eaten,	116	170	467	3,980
21. *Dietary of a Carpenter's Family.*§				
Food, Purchased,	118	135	539	3,955
Waste,	3	9	2	105
Eaten,	115	126	537	3,850
*Three Dietaries of a Chemist's Family.***				
26. November, 1894.				
Food, Purchased,	104	122	385	3,140
Waste,	2	24	7	260
Eaten,	102	98	378	2,880
28. February, 1895.				
Food purchased and eaten,	91	150	399	3,405
29. May, 1895.				
Food, Purchased,	124	155	414	3,650
Waste,	2	8	4	100
Eaten,	122	147	410	3,550
Average of 26, 28 and 29.				
Food, Purchased,	106	142	400	3,400
Waste,	1	10	4	120
Eaten,	105	132	396	3,280
27. *Dietary of a Farmer's Family in Vermont.***				
Food purchased, ‖	69	92	444	2,960
*Two Dietaries of a Farmer's Family.***				
45.				
Food purchased and eaten,	108	76	635	3,755

TABLE 63.—*(Continued.)*

DIETARIES.	NUTRIENTS.			FUEL VALUE.
	Protein.	Fat.	Carbo-hydrates.	
	Grams.	Grams.	Grams.	Calories.
46.				
Food purchased and eaten,	109	91	608	3,785
Average of 45 and 46.				
Food purchased and eaten,	109	83	622	3,770
120. *Dietary of a Farmer's Family.***				
Food, Purchased,	114	139	545	3,995
Food, Waste,	14	18	44	405
Food, Eaten,	100	121	501	3,590
121. *Dietary of a Farmer's Family.***				
Food purchased and eaten,	79	117	354	2,865
123. *Dietary of a Farmer's Family.***				
Food, Purchased,	140	174	456	4,060
Food, Waste,	9	13	23	255
Food, Eaten,	131	161	433	3,810
124. *Dietary of College Students.***				
Food, Purchased,	137	186	557	4,575
Food, Waste,	33	30	63	675
Food, Eaten,	104	156	494	3,900
Results of 31 Dietary Studies.				
Food eaten, Minimum,	69	76	317	2,865
Food eaten, Maximum,	133	171	636	4,300
Food eaten, Average,	107	132	436	3,455
Dietary Standards for Men at Moderate Work.				
Voit (German),	118	50	500	3,060
Atwater (American),	125	125	450	3,520

* Report of this Station, 1891, pp. 90–106.
† Report of this Station, 1892, pp. 135–162.
‡ Report of this Station, 1893, pp. 174–190.
§ Report of this Station, 1894, pp. 174–201.
‖ There was little or no waste in this dietary.
** This Report, pp. 129–170.

RESULTS OF ANALYSES OF FODDERS AND FEEDING STUFFS.

BY CHAS. D. WOODS.

In connection with the work of the Station, analyses of the following miscellaneous feeding stuffs have been made by the Station chemists. For the most part the analyses were made in connection with feeding experiments or experiments upon the growth of plants. In no case were they undertaken merely to increase the amount of this class of data. The methods of analyses recommended by the Association of Official Agricultural Chemists were employed.

The results of the analyses as calculated to water content at harvest or at the time of analyses are given in table 64, page 180, which follows the description of samples. In this table the materials are grouped somewhat according to their water content at time of taking samples, as follows: Green fodders; silage; cured hay and fodder; grain; and milling products. This order is also observed in the description of samples.

The results calculated to water-free substance (dry matter) as the basis are given in table 65, page 183.

The fuel value of a pound of each of the feeding stuffs as given in the tables was obtained by multiplying the number of hundredths of a pound of protein and of carbohydrates by 18.6, and the number of hundredths of a pound of fat by 42.2, and taking the sum of these three products as the number of calories of potential energy in the materials.*

DESCRIPTION OF SAMPLES.

In the description of samples the order of arrangement is the same as in the tables.

GREEN FODDERS.

1533, 1534, *Barley.*—Grown by the Station in 1895. The samples were taken August 15 and 19, at which time the heads were about three-fourths grown and were green and succulent. The samples were selected from barley and pea fodder. About 47 per cent. of the fodder was barley.

*See paper on Fuel Value of Feeding Stuffs in Report of this Station for 1890, pp. 174–181.

1472, 1473, *Hungarian Grass.*—Grown by the Station in 1895. Samples taken August 1 and 5, at which time the grass was nearly full grown and beginning to bloom.

1514, 1515, *Hungarian Grass.*—Grown by the Station in 1895. Samples taken August 15 and 19, at which time the grass was a little past full bloom. Sample No. 1515 was in the early seed stage and the stems were quite woody.

1470, 1471, *Oats.*—Grown by the Station in 1895. Samples were taken July 10 and 13, at which time the oats were beginning to bloom although many heads were not full grown. No. 1471 was a little more mature than No. 1470.

1468, *Oats and Peas.*—Grown by the Station in 1895. Harvested July 10, at which time the oats were just beginning to bloom. Many heads were not full grown. The peas were in bloom but no seed had formed.

1469, *Oats and Peas.*—Grown by the Station in 1895. Sample taken July 14, at which time the oats were generally in early bloom. The peas were mostly in bloom and quite succulent. There were a few pods and immature seeds.

1535, 1536, *Canada Field Peas.*—Grown by the Station in 1895. Samples taken August 15 and 19, at which time the peas were about three-fourths grown, and were leafy and succulent. It was grown as barley and pea fodder. The peas were separated from the barley and constituted about 53 per cent. of the whole.

1485—1494, *Cow Pea Vines.*—Grown by the Station in 1895. The samples were taken September 21. Nos. 1485 and 1486 were from plots without fertilizers. Nos. 1487 and 1488 were from plots to which there were applied dissolved bone-black at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds. Nos. 1489, 1490 and 1491 were grown on plots to which mixed minerals were applied as in 1487 and 1488 and had in addition 160, 320 and 480 pounds of nitrate of soda per acre respectively. Nos. 1492, 1493 and 1494 were grown on plots to which mixed minerals were applied as in 1487 and 1488 and had in addition 120, 240 and 360 pounds of sulphate of ammonia per acre respectively.

1499, 1500, *Cow Pea Vines.*—Grown on the college farm in 1895. Samples were taken September 12 and 16. There was a medium heavy growth although the vines were not full grown.

1476, *Flat Pea.*—Grown by the Station in 1895. Sample taken July 19, at which time the plants were in bloom, a very few pods having formed. There was a heavy, dense growth.

1474, 1475, *Soy Bean Vines.*—Grown by the Station in 1895. Samples taken August 3 and 5, at which time the plants were in bloom. There was a heavy, dense growth.

1495, *Soy Bean Vines.*—Grown by the Station in 1895. Sample taken September 24. The plants were small but leafy.

1516, *Soy Bean Vines.*—Grown by the Station in 1895. Sample taken August 28. The plants were beginning to form seed. Stems were quite hard.

1517, *Soy Bean Vines.*—Grown by the Station in 1895. Sample taken August 31. Pods generally formed. Seeds about half grown in the more advanced pods.

1530, 1531, *Timothy Rowen.*—Grown by the Station in 1895. Timothy with a small percentage of clover and fine grasses.

1512, 1513, *Clover Rowen.*—Grown in 1895. One-tenth to one-eighth mixed grasses. Clover a little past full bloom. Grasses one-third grown.

1496, *Corn Fodder.*—Grown by the Station in 1895. Sample taken September 24. Medium heavy growth.

1497, *Corn Fodder.*—Grown by the Station in 1895. In early roasting stage. Kernels not fully grown on many ears.

1498, *Corn Fodder.*—Grown by the Station in 1895. Ears from roasting stage to beginning to harden.

1518, *Sweet Corn Fodder.*—Grown by the Station in 1895. Sample taken August 28. First ears ready for roasting; many not yet fully grown. Many stalks with no ears or only "nubbins."

1519, *Sweet Corn Fodder.*—Grown by the Station in 1895. Sample taken August 31. Ears in roasting stage. Ears on most stalks but many of the ears small.

1532, *Corn Fodder.*—Grown by the Station in 1895. Sample taken September 28.

ENSILAGE.

1377, 1423, *Corn Ensilage.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

CURED HAY AND FODDERS.

1389, 1394, 1408, 1415, 1427, 1447, *Corn Stover.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1537—1546, *Corn Stover.*—Grown by the Station in 1895. Nos. 1537 and 1538 were from plots without fertilizers. Nos. 1539 and 1540 were from plots to which there were applied dissolved bone-black at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds. Nos. 1541, 1542 and 1543 were grown on plots to which mixed minerals were applied as in 1539 and 1540 and had in addition 160, 320 and 480 pounds of nitrate of soda per acre respectively. Nos. 1544, 1545 and 1546 were grown on plots to which mixed minerals were applied as in 1539 and 1540 and had in addition 120, 240 and 360 pounds of sulphate of ammonia per acre respectively.

1557—1566, *Corn Stover.*—Grown by the Station in 1895. Nos. 1557 and 1558 were from plots without fertilizers. Nos. 1559 and 1560 were from plots to which there were applied dissolved bone-black at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds per acre. Nos. 1561, 1562 and 1563 were grown on plots to which mixed minerals were applied as in 1559 and 1560 and had in addition 160, 320 and 480 pounds of nitrate of soda per acre respectively. Nos. 1564, 1565 and 1566 were grown on plots to which mixed minerals were applied as in 1559 and 1560 and had in addition 120, 240 and 360 pounds of sulphate of ammonia per acre respectively.

1437, 1453, *Corn Fodder and Stover.*—Samples taken in connection with studies of feeding during the winter of 1894–95. Half sweet corn fodder and half field corn stover.

1418, *Scarlet Clover Hay.*—Grown by the Station in 1894. Field cured.

1432, *Scarlet Clover Hay.*—Grown by the Station in 1894. Cured in the barn.

1446, *Clover Hay.*—Sample taken in connection with feeding experiments throughout the State during the winter of 1894–95. It contained some sorrel.

1451, *Clover Hay.*—Same as 1446 except that sorrel had been removed.

1392, *Hay, Mixed Grasses.*—Redtop and timothy. Taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1416, 1436, *Hay, Mixed Grasses.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1452, *Hay, Hungarian.*—Sample taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1399, *Timothy Rowen.*—Grown by the Station in 1894. Nearly clear timothy. A small amount of barn-yard grass.

1433, 1438, *Timothy Rowen.*—Grown by the Station in 1894. Mostly timothy.

1400, *Rowen Hay.*—Grown by the Station in 1894. Mixed grasses with a little clover.

1393, 1414, 1426, 1445, *Oat Hay.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1428, 1444, *Swamp Hay.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

SEEDS.

1462, 1463, *Flint Corn.*—Grown in 1894.

1464, 1467, *Yellow Flint Corn.*—Grown in 1894.

1465, 1466, *White Flint Corn.*—Grown in 1894.

1547—1556, *Flint Corn.*—Grown by the Station in 1895. Nos. 1547 and 1548 were from plots without fertilizers. Nos. 1549 and 1550 were from plots to which were applied dissolved bone-black at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds per acre. Nos. 1551, 1552 and 1553 were grown on plots to which mixed minerals were applied as in 1549 and 1550 and had in addition 160, 320 and 480 pounds of nitrate of soda per acre respectively. Nos. 1554, 1555 and 1556 were grown on plots to which mixed minerals were applied as in 1549 and 1550 and had in addition 120, 240 and 360 pounds of sulphate of ammonia per acre respectively.

1567—1576, *Flint Corn.*—Grown by the Station in 1895. Nos. 1567 and 1568 were from plots without fertilizers. Nos. 1569 and 1570 were from plots to which there were applied dissolved bone-black at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds per acre. Nos. 1571, 1572 and 1573 were grown on plots to which mixed minerals were applied as in 1569 and 1570 and had in addition 160, 320 and 480 pounds of nitrate of soda per acre respectively. Nos. 1574, 1575 and 1576 were grown on plots to which

mixed minerals were applied as in 1569 and 1570 and had in addition 120, 240 and 360 pounds of sulphate of ammonia per acre respectively.

1577—1586, *Soy Beans.*—Grown by the Station in 1895. Nos. 1577 and 1578 were from plots without fertilizers. Nos. 1579 and 1580 were from plots to which there were applied dissolved bone-black at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds per acre. Nos. 1581, 1582 and 1583 were grown on plots to which mixed minerals were applied as in 1579 and 1580 and had in addition 160, 320 and 480 pounds of nitrate of soda per acre respectively. Nos. 1584, 1585 and 1586 were grown on plots to which mixed minerals were applied as in 1579 and 1580 and had in addition 120, 240 and 360 pounds of sulphate of ammonia per acre respectively.

1587, *Soy Bean.*—Grown by the Station in 1895. Medium early.

1378, *Wheat.*—Sample taken in connection with feeding experiments throughout the State during the winter of 1894–95. No. 2 wheat used in feeding sheep.

1501, *Wheat.*—Sample taken in connection with feeding experiments throughout the State during the winter of 1895–96. No. 2 wheat used in feeding sheep.

MILLING AND BY-PRODUCTS.

1381, 1388, 1406, *Corn Meal.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1502, *Corn Meal.*—From flint corn grown by the Station in 1895.

1391, 1411, 1424, 1441, *Corn and Cob Meal.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1442, 1448, *Cotton Seed Meal.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1434, 1449, *Buffalo Gluten Meal.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1390, 1413, *Imperial Feed.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1405, *Malt Sprouts.*—Sample taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1412, *Linseed Meal, Old Process.*—Sample taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1439, 1440, *Soy Bean Meal.*—Meal of soy beans grown by the Station in 1895.

1379, *Culled Peas.*—Sample taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1382, *Refuse from Manufacture of Split Peas.*—Sample taken in connection with feeding experiments throughout the State during the winter of 1894–95. Sample consisted of hulls and broken pieces of peas.

1380, 1435, 1443, 1450, *Wheat Bran.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

1387, 1407, *Wheat Middlings.*—Samples taken in connection with feeding experiments throughout the State during the winter of 1894–95.

TABLE 64.

Composition of Fodders and Feeding Stuffs Analyzed 1894–95. Calculated to Water Content at Time of Taking Sample.

Lab. No.	Feeding Stuffs.	Water.	Protein.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Fuel Value Per Pound.
	Green Fodders.	%	%	%	%	%	%	Cal.
1533	Barley,	81.70	3.18	.87	8.34	3.97	1.94	325
1534	Barley,	77.45	3.67	.74	10.04	5.98	2.12	395
1472	Hungarian grass,	78.56	2.58	2.06	9.08	5.72	2.00	410
1473	Hungarian grass,	78.77	2.63	.81	9.53	6.08	2.18	375
1514	Hungarian grass,	71.26	2.71	.93	13.80	8.94	2.36	510
1515	Hungarian grass,	76.27	2.12	.81	11.35	7.27	2.18	420
1470	Oats,	81.75	2.75	1.08	7.84	4.65	1.93	330
1471	Oats,	78.91	2.59	.94	9.64	6.05	1.87	375
1468	Oats and peas,	84.54	3.19	.98	6.09	3.58	1.62	280
1469	Oats and peas,	83.25	3.45	.97	6.54	4.07	1.72	305
1535	Peas,	87.68	3.27	.66	4.12	2.80	1.47	220
1536	Peas,	85.34	4.06	.74	5.36	3.08	1.42	260
1485	Cow pea vines,	81.16	3.36	.72	9.08	3.85	1.83	330
1486	Cow pea vines,	81.22	2.83	.71	9.31	4.16	1.77	330
1487	Cow pea vines,	79.58	3.42	.71	9.25	5.08	1.96	360
1488	Cow pea vines,	81.22	2.89	.61	9.55	4.02	1.71	330
1489	Cow pea vines,	81.73	3.21	.59	8.50	4.33	1.64	325
1490	Cow pea vines,	82.20	3.19	.63	7.99	4.44	1.55	315
1491	Cow pea vines,	82.29	3.24	.68	8.38	3.79	1.62	315
1492	Cow pea vines,	81.68	3.37	.68	8.54	3.86	1.87	325
1493	Cow pea vines,	82.63	3.16	.73	8.13	3.50	1.85	305
1494	Cow pea vines,	82.40	2.83	.60	8.73	3.67	1.77	310
1499	Cow pea vines,	79.84	3.36	.89	10.22	3.36	2.33	355
1500	Cow pea vines,	80.19	3.22	.75	10.17	3.52	2.15	345
1476	Flat pea,	84.10	4.81	.88	4.57	4.33	1.31	295
1474	Soy bean,	80.86	3.49	.71	7.65	5.17	2.12	330
1475	Soy bean,	76.87	4.05	1.01	9.33	5.82	2.92	400
1495	Soy bean,	75.33	5.39	.89	10.58	5.21	2.60	435
1516	Soy bean,	75.41	3.29	1.00	11.65	6.43	2.22	440
1517	Soy bean,	74.21	3.19	1.00	11.94	7.46	2.20	460
1530	Timothy rowen,	63.28	5.57	2.06	17.15	8.99	2.95	680
1531	Timothy rowen,	71.07	4.95	1.77	12.61	7.19	2.41	535
1512	Clover rowen,	76.76	3.93	1.11	10.04	6.10	2.06	420
1513	Clover rowen,	71.93	4.76	1.40	12.19	7.34	2.38	510
1496	Corn fodder,	82.05	1.80	.45	10.97	3.70	1.03	325
1497	Corn fodder,	78.60	2.02	.78	12.97	4.43	1.20	395
1498	Corn fodder,	77.99	1.91	.91	14.53	3.64	1.02	410
1518	Corn fodder,	80.41	1.77	.64	11.50	4.42	1.26	355
1519	Corn fodder,	78.38	1.64	.52	13.60	4.65	1.21	390
1532	Corn fodder,	80.33	1.77	.61	12.55	3.58	1.16	360
	Ensilage.							
1377	Corn ensilage,	60.30	2.97	1.41	22.76	9.93	2.63	720
1423	Corn ensilage,	82.22	1.01	.98	9.10	5.68	1.01	335
	Cured Hay and Fodders.							
1389	Corn stover,	32.92	4.61	1.61	33.24	21.53	6.09	1,170
1394	Corn stover,	8.03	7.63	2.43	42.67	32.39	6.85	1,640
1408	Corn stover,	14.99	5.68	1.94	42.88	28.55	5.96	1,515

TABLE 64.—*(Continued)*

Lab. No.	Feeding Stuffs.	Water.	Protein.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Fuel Value Per Pound.
	Green Fodders.	%	%	%	%	%	%	Cal.
1415	Corn stover, - -	10.44	7.80	1.83	42.98	31.27	5.68	1,600
1427	Corn stover, - -	20.02	6.76	1.83	38.74	25.79	6.86	1,405
1447	Corn stover, - -	22.09	5.37	1.52	36.60	27.89	6.53	1,365
1537	Corn stover, - -	28.70	4.15	1.10	37.02	25.26	3.77	1,280
1538	Corn stover, - -	19.85	4.74	1.40	41.74	29.04	3.23	1,465
1539	Corn stover, - -	37.72	2.94	1.40	33.47	20.95	3.52	1,125
1540	Corn stover, - -	35.43	2.99	1.34	32.81	23.92	3.51	1,165
1541	Corn stover, - -	32.47	3.23	1.18	35.95	23.70	3.47	1,220
1542	Corn stover, - -	27.74	4.30	1.54	37.12	25.28	4.02	1,240
1543	Corn stover, - -	37.85	2.87	1.16	32.26	22.87	2.99	1,130
1544	Corn stover, - -	33.40	4.25	1.21	34.79	22.89	3.46	1,200
1545	Corn stover, - -	38.67	2.71	1.05	33.21	21.49	2.87	1,110
1546	Corn stover, - -	36.67	3.64	1.08	32.99	22.18	3.44	1,140
1557	Corn stover, - -	27.57	4.06	1.27	39.82	23.05	4.23	1,300
1558	Corn stover, - -	29.56	5.00	1.24	36.41	22.36	5.43	1,240
1559	Corn stover, - -	35.15	2.20	1.09	35.70	21.77	4.09	1,155
1560	Corn stover, - -	35.08	2.53	1.57	35.21	21.18	4.43	1,160
1561	Corn stover, - -	35.57	2.15	1.17	34.90	22.75	3.46	1,160
1562	Corn stover, - -	40.21	3.20	1.11	32.48	19.53	3.47	1,075
1563	Corn stover, - -	38.09	4.24	1.05	32.18	20.78	3.66	1,110
1564	Corn stover, - -	39.01	2.70	1.04	33.27	19.99	3.99	1,085
1565	Corn stover, - -	41.06	2.68	1.02	31.97	19.26	4.01	1,045
1566	Corn stover, - -	36.24	4.14	1.23	34.09	18.44	5.86	1,105
1437	Corn fodder and stover mixed, - -	16.97	4.57	2.54	39.73	30.12	6.07	1,490
1453	Corn fodder and stover mixed, - -	19.72	5.67	2.20	39.09	25.20	8.12	1,395
1418	Hay, scarlet clover, -	13.90	14.10	1.80	31.60	31.30	7.30	1,750
1432	Hay, scarlet clover, -	19.61	15.50	1.92	29.75	25.92	7.30	1,405
1446	Hay, clover, - -	11.60	10.05	2.64	39.77	29.45	6.49	1,585
1451	Hay, clover, - -	8.01	14.06	4.69	47.40	19.14	6.70	1,700
1392	Hay, mixed grasses,	4.90	6.25	3.12	47.52	32.19	6.02	1,730
1410	Hay, mixed grasses,	9.06	7.62	2.77	43.09	31.81	5.65	1,650
1436	Hay, mixed grasses,	8.96	6.82	2.72	46.71	30.14	4.65	1,670
1452	Hay, Hungarian, -	8.81	8.19	2.76	45.75	28.04	6.45	1,640
1399	Hay, Timothy rowen,	18.61	13.19	4.33	32.49	24.80	6.58	1,495
1433	Hay, Timothy rowen,	13.49	15.22	4.69	36.02	23.53	7.05	1,590
1438	Hay, Timothy rowen,	13.19	14.91	4.11	36.10	24.58	7.11	1,580
1400	Hay, rowen, mixed grasses, - -	14.76	14.65	4.53	35.58	24.10	6.38	1,570
1393	Hay, oat, - -	6.09	8.13	3.52	44.14	32.61	5.51	1,725
1414	Hay, oat, - -	11.29	8.33	3.14	43.06	28.84	5.34	1,625
1426	Hay, oat, - -	7.35	9.75	3.97	45.93	27.65	5.35	1,720
1445	Hay, oat, - -	9 47	8.26	3.27	44.19	29.16	5.65	1,660
1428	Hay, swamp, - -	6.85	10.25	3.62	45.81	27.56	5.91	1,705
1444	Hay, swamp, - -	11.29	9.47	3.35	43.12	26.67	6.10	1,615
	Seeds.							
1462	Corn, - - -	8.76	9.81	7.19	70.74	1.49	2.01	1,830
1463	Corn, - - -	11.14	9.94	8.47	66.78	1.55	2.12	1,815
1464	Corn, - - -	11.71	11.19	5.05	69.14	1.41	1.50	1,735
1465	Corn, - - -	12.32	10.62	5.67	68.51	1.36	1.52	1,740

TABLE 64.—*(Continued.)*

Lab. No.	FREDING STUFFS.	Water.	Protein.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Fuel Value Per Pound.
	Seeds.	%	%	%	%	%	%	Cal.
1466	Corn, - - -	11.31	11.56	6.49	66.79	2.19	1.66	1,770
1467	Corn, - - -	11.80	11.62	8.39	63.68	2.11	2.40	1,795
1547	Corn, field cured, -	22.90	8.00	4.51	61.97	1.27	1.35	1,515
1548	Corn, field cured, -	20.82	8.64	4.17	63.98	1.07	1.32	1,550
1549	Corn, field cured, -	21.25	7.06	5.12	63.72	1.48	1.37	1,560
1550	Corn, field cured, -	22.94	6.69	4.53	62.86	1.69	1.29	1,515
1551	Corn, field cured, -	23.36	7.87	4.62	61.70	1.09	1.36	1,510
1552	Corn, field cured, -	23.08	8.40	4.96	61.03	1.14	1.39	1,525
1553	Corn, field cured, -	25.05	8.94	4.35	59.19	1.19	1.28	1,475
1554	Corn, field cured, -	23.89	7.82	5.09	60.78	1.16	1.26	1,510
1555	Corn, field cured, -	25.04	7.77	4.59	60.27	1.12	1.21	1,480
1556	Corn, field cured, -	23.95	9.21	5.23	59.01	1.19	1.41	1,510
1567	Corn, field cured, -	19.78	8.36	5.15	63.85	1.34	1.52	1,585
1568	Corn, field cured, -	19.53	8.50	4.38	65.13	1.16	1.30	1,575
1569	Corn, field cured, -	20.42	7.81	5.23	63.94	1.16	1.44	1,575
1570	Corn, field cured, -	21.08	8.23	5.16	62.82	1.22	1.49	1,565
1571	Corn, field cured, -	20.22	8.47	6.12	62.14	1.33	1.72	1,595
1572	Corn, field cured, -	21.11	9.37	5.47	61.35	1.21	1.49	1,570
1573	Corn, field cured, -	22.05	9.73	5.50	59.89	1.21	1.62	1,550
1574	Corn, field cured, -	20.82	8.71	5.47	62.25	1.21	1.54	1,575
1575	Corn, field cured, -	20.86	9.04	5.88	61.38	1.22	1.62	1,580
1576	Corn, field cured, -	20.83	9.65	5.58	61.16	1.18	1.60	1,575
1577	Soy beans, - -	9.21	31.93	17.99	25.58	2.93	12.36	1,880
1578	Soy beans, - -	10.30	35.27	18.10	25.02	2.93	8.38	1,940
1579	Soy beans, - -	10.68	31.35	19.98	28.55	3.01	6.43	2,015
1580	Soy beans, - -	10.42	34.08	19.12	27.38	3.15	5.85	2,005
1581	Soy beans, - -	9.94	33.28	19.56	27.49	2.92	6.81	2,010
1582	Soy beans, - -	9.12	35.71	19.49	27.17	2.96	5.55	2,045
1583	Soy beans, - -	10.02	37.25	18.38	25.78	3.06	5.51	2,005
1584	Soy beans, - -	9.65	33.31	19.84	27.97	3.23	6.00	2,035
1585	Soy beans, - -	11.61	33.34	19.08	27.75	2.98	5.24	1,995
1586	Soy beans, - -	10.37	35.69	18.56	26.06	3.13	6.19	1,990
1587	Soy beans, - -	8.61	34.85	20.81	26.15	3.40	6.18	2,075
1378	Wheat, - - -	10.74	13.50	1.87	71.02	1.48	1.39	1,680
1501	Wheat, - - -	9.59	18.81	5.53	55.08	7.00	3.99	1,735
	Milling and By-Products.							
1381	Corn meal, - -	14.04	9.63	5.15	68.41	1.13	1.64	1,690
1388	Corn meal, - -	11.72	9.19	4.16	72.32	1.20	1.41	1,715
1406	Corn meal, - -	11.03	11.75	5.06	68.65	1.95	1.56	1,745
1502	Corn meal, - -	9.51	11.31	4.72	71.68	1.31	1.47	1,765
1391	Corn and cob meal, -	9 63	10.50	3.96	72.17	2.46	1.28	1,750
1411	Corn and cob meal, -	14.74	8.88	3.57	67.93	3.51	1.37	1,645
1424	Corn and cob meal, -	13.66	9.94	3.71	66.19	5.13	1.37	1,670
1441	Corn and cob meal, -	12.99	7.69	5.58	68.48	3.55	1.71	1,720
1442	Cotton seed meal, -	7.12	26.56	9.15	45.28	4.75	7.14	1,810
1448	Cotton seed meal, -	6.20	33.31	10.61	40.27	2.66	6.95	1,865
1434	Buffalo gluten meal, -	8.47	27.25	15.62	41.32	6.43	.91	2,055
1449	Buffalo gluten meal, -	7.97	27.94	15.71	41.12	6.18	1.08	2,065
1390	Imperial feed, - -	7.83	16.75	4.60	60.78	5.88	4.16	1,745
1413	Imperial feed, - -	11.26	17.03	4.43	55.74	6.53	5.01	1,660

TABLE 64.—*(Continued.)*

Lab. No.	Feeding Stuffs.	Water.	Protein.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Fuel Value Per Pound.
	Milling and By-Products.	%	%	%	%	%	%	Cal.
1405	Malt sprouts, - -	8.43	27.19	2.88	42.79	11.87	6.84	1,645
1412	O. P. linseed meal, -	8.99	26.75	2.54	48.83	7.54	5.35	1,650
1439	Soy bean meal, -	10.76	35.56	18.56	27.38	2.58	5.16	2,000
1440	Soy bean meal, -	10.06	36.44	19.12	26.64	2.59	5.15	2,025
1379	Culled peas, - -	11.10	25.06	1.43	56.23	2.93	3.25	1,625
1382	Refuse from manufacture of split peas, -	7.57	16.75	1.36	35.51	26.49	12.32	1,525
1380	Wheat bran, - -	8.61	17.87	4.99	55.89	7.63	5.01	1,725
1435	Wheat bran, - -	7.96	20.38	5.65	52.42	8.65	4.94	1,755
1443	Wheat bran, - -	8.33	17.50	4.79	56.74	7.85	4.79	1,730
1450	Wheat bran, - -	8.32	17.00	5.13	56.56	8.31	4.68	1,740
1387	Wheat middlings, -	9.59	18.94	5.10	58.49	4.44	3.44	1,740
1407	Wheat middlings, -	10.48	18.13	4.40	61.08	3.42	2.49	1,720

TABLE 65.

Composition of Water-free Substance of Fodders and Feeding Stuffs Analyzed 1894–95.

Lab. No.	Feeding Stuffs.	Protein.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Fuel Value Per Pound.
	Green Fodders.	%	%	%	%	%	Cal.
1533	Barley, - - - -	17.38	4.75	45.58	21.69	10.60	1,775
1534	Barley, - - - -	16.27	3.28	44.53	26.52	9.40	1,765
1472	Hungarian grass, - -	12.04	9.61	42.34	26.67	9.34	1,915
1473	Hungarian grass, - -	12.41	3.80	44.86	28.65	10.28	1,760
1514	Hungarian grass, - -	9.44	3.25	47.97	31.12	8.22	1,785
1515	Hungarian grass, - -	8.95	3.40	47.83	30.64	9.18	1,770
1470	Oats, - - - - -	15.06	5.89	42.95	25.49	10.61	1,800
1471	Oats, - - - - -	12.29	4.47	45.69	28.68	8.87	1,800
1468	Oats and peas, - - -	20.61	6.37	39.42	23.13	10.47	1,820
1469	Oats and peas, - - -	20.62	5.82	39.05	24.26	10.25	1,805
1535	Peas, - - - - -	26.54	5.36	33.44	22.73	11.93	1,775
1536	Peas, - - - - -	27.70	5.05	36.56	21.01	9.68	1,800
1485	Cow pea vines, - - -	17.84	3.82	48.18	20.43	9.73	1,770
1486	Cow pea vines, - - -	15.05	3.77	49.62	22.15	9.41	1,775
1487	Cow pea vines, - - -	16.73	3.47	45.31	24.87	9.62	1,760
1488	Cow pea vines, - - -	15.40	3.27	50.85	21.37	9.11	1,770
1489	Cow pea vines, - - -	17.57	3.21	46.54	23.69	8.99	1,770
1490	Cow pea vines, - - -	17.94	3.53	44.85	24.95	8.73	1,780
1491	Cow pea vines, - - -	18.28	3.81	47.38	21.39	9.14	1,780
1492	Cow pea vines, - - -	18.39	3.74	46.63	21.05	10.19	1,760
1493	Cow pea vines, - - -	18.20	4.21	46.78	20.17	10.64	1,760
1494	Cow pea vines, - - -	16.09	3.43	49.58	20.88	10.02	1,755

TABLE 65.—*(Continued.)*

Lab. No.	Feeding Stuffs.	Protein.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Fuel Value Per Pound.
	Green Fodders.	%	%	%	%	%	Cal.
1499	Cow pea vines,	16.65	4.54	50.60	16.62	11.59	1,750
1500	Cow pea vines,	16.25	3.80	51.23	17.89	10.83	1,750
1476	Flat pea vines,	30.25	5.52	28.74	27.25	8.24	1,835
1474	Soy bean vines,	18.22	3.73	39.97	27.00	11.08	1,740
1475	Soy bean vines,	17.51	4.36	40.32	25.17	12.64	1,730
1495	Soy bean vines,	21.83	3.62	42.90	21.13	10.52	1,750
1516	Soy bean vines,	13.38	4.05	47.38	26.17	9.02	1,785
1517	Soy bean vines,	12.37	3.87	46.31	28.92	8.53	1,795
1530	Timothy rowen,	15.18	5.61	46.69	24.49	8.03	1,845
1531	Timothy rowen,	17.10	6.12	43.59	24.85	8.34	1,845
1512	Clover rowen,	16.90	4.79	43.19	26.24	8.88	1,810
1513	Clover rowen,	16.96	4.97	43.46	26.13	8.48	1,820
1496	Corn fodder,	10.04	2.50	61.10	20.60	5.76	1,810
1497	Corn fodder,	9.43	3.66	60.61	20.69	5.61	1,840
1498	Corn fodder,	8.67	4.14	66.03	16.53	4.63	1,870
1518	Corn fodder,	9.03	3.28	58.67	22.58	6.44	1,820
1519	Corn fodder,	7.59	2.42	62.88	21.51	5.60	1,810
1532	Corn fodder,	8.98	3.11	63.84	18.19	5.88	1,825
	Ensilage.						
1377	Corn ensilage,	7.48	3.55	57.33	25.01	6.63	1,820
1423	Corn ensilage,	5.68	5.51	51.18	31.95	5.68	1,885
	Cured Hay and Fodders.						
1389	Corn stover,	6.87	2.40	49.55	32.10	9.08	1,735
1394	Corn stover,	8.30	2.64	46.40	35.22	7.44	1,780
1408	Corn stover,	6.68	2.28	50.44	33.58	7.02	1,785
1415	Corn stover,	8.71	2.04	48.00	34.91	6.34	1,790
1427	Corn stover,	8.45	2.29	48.44	32.25	8.57	1,755
1447	Corn stover,	6.89	1.95	46.98	35.80	8.38	1,750
1537	Corn stover,	5.82	1.54	51.92	35.43	5.29	1,800
1538	Corn stover,	5.91	1.75	52.08	36.23	4.03	1,825
1539	Corn stover,	4.72	2.24	53.73	33.65	5.66	1,805
1540	Corn stover,	4.62	2.08	50.82	37.05	5.43	1,810
1541	Corn stover,	4.77	1.74	53.24	35.10	5.15	1,805
1542	Corn stover,	5.95	2.13	51.38	34.98	5.56	1,805
1543	Corn stover,	4.61	1.86	51.92	36.81	4.80	1,815
1544	Corn stover,	6.38	1.81	52.24	34.37	5.20	1,805
1545	Corn stover,	4.42	1.72	54.15	35.04	4.67	1,810
1546	Corn stover,	5.75	1.71	52.09	35.02	5.43	1,800
1557	Corn stover,	5.60	1.75	54.98	31.82	5.85	1,795
1558	Corn stover,	7.10	1.77	51.68	31.74	7.71	1,760
1559	Corn stover,	3.40	1.68	55.05	33.57	6.30	1,785
1560	Corn stover,	3.90	2.42	54.23	32.63	6.82	1,790
1561	Corn stover,	3.34	1.82	54.18	35.30	5.36	1,800
1562	Corn stover,	5.34	1.85	54.33	32.67	5.81	1,800
1563	Corn stover,	6.86	1.70	51.97	33.56	5.91	1,790
1564	Corn stover,	4.42	1.70	54.56	32.77	6.55	1,780
1565	Corn stover,	4.54	1.73	54.24	32.68	6.81	1,775
1566	Corn stover,	6.50	1.93	53.46	28.93	9.18	1,735
1437	Corn fodder and stover mixed,	5.51	3.06	47.85	36.27	7.31	1,795
1453	Corn fodder and stover mixed,	7.07	2.74	48.70	31.38	10.11	1,735

TABLE 65.—*(Continued.)*

Lab. No.	Feeding Stuffs.	Protein.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Fuel Value Per Pound.
	Cured Hay and Fodders.	%	%	%	%	%	Cal.
1418	Hay, scarlet clover,	16.36	2.07	36.74	36.32	8.51	1,750
1432	Hay, scarlet clover,	19.28	2.39	37.01	32.24	9.08	1,745
1446	Hay, clover,	11.37	2.98	44.99	33.32	7.34	1,795
1451	Hay, clover,	15.28	5.10	51.52	20.81	7.29	1,845
1392	Hay, mixed grasses,	6.57	3.28	49.97	33.85	6.33	1,815
1416	Hay, mixed grasses,	8.38	3.04	47.39	34.98	6.21	1,815
1436	Hay, mixed grasses,	7.49	2.99	51.31	33.11	5.10	1,835
1452	Hay, Hungarian,	8.98	3.03	50.16	30.75	7.08	1,800
1399	Hay, Timothy rowen,	16.21	5.32	39.92	30.47	8.08	1,835
1433	Hay, Timothy rowen,	17.59	5.42	41.64	27.20	8.15	1,835
1438	Hay, Timothy rowen,	17.18	4.73	41.59	28.32	8.18	1,820
1400	Hay, rowen, mixed grasses,	17.19	5.31	41.74	28.28	7.48	1,845
1393	Hay, oat,	8.65	3.75	47.02	34.72	5.86	1,840
1414	Hay, oat,	9.39	3.54	48.54	32.51	6.02	1,830
1426	Hay, oat,	10.52	4.28	49.58	29.84	5.78	1,855
1445	Hay, oat,	9.12	3.61	48.82	32.21	6.24	1,830
1428	Hay, swamp,	11.01	3.88	49.18	29.59	6.34	1,835
1444	Hay, swamp,	10.68	3.77	48.61	30.06	6.88	1,825
	Seeds.						
1462	Corn,	10.76	7.88	77.54	1.63	2.19	2,005
1463	Corn,	11.18	9.53	75.16	1.74	2.39	2,040
1464	Corn,	12.68	5.72	78.30	1.60	1.70	1,965
1465	Corn,	12.11	6.47	78.14	1.55	1.73	1,980
1466	Corn,	13.03	7.32	75.31	2.47	1.87	1,995
1467	Corn,	13.18	9.51	72.20	2.39	2.72	2,035
1547	Corn,	10.37	5.85	80.37	1.65	1.76	1,970
1548	Corn,	10.91	5.26	80.81	1.36	1.66	1,955
1549	Corn,	8.97	6.49	80.92	1.88	1.74	1,980
1550	Corn,	8.68	5.88	81.57	2.20	1.67	1,970
1551	Corn,	10.26	6.03	80.51	1.42	1.78	1,970
1552	Corn,	10.92	6.45	79.34	1.49	1.80	1,980
1553	Corn,	11.93	5.80	78.97	1.59	1.71	1,965
1554	Corn,	10.27	6.69	79.86	1.53	1.65	1,990
1555	Corn,	10.37	6.12	80.40	1.50	1.61	1,975
1556	Corn,	12.11	6.87	77.60	1.57	1.85	1,990
1567	Corn,	10.42	6.43	79.59	1.67	1.89	1,975
1568	Corn,	10.56	5.44	80.95	1.44	1.61	1,960
1569	Corn,	9.81	6.57	80.35	1.46	1.81	1,980
1570	Corn,	10.42	6.54	79.60	1.55	1.89	1,980
1571	Corn,	10.62	7.67	77.89	1.67	2.15	2,005
1572	Corn,	11.87	6.94	77.77	1.53	1.89	1,985
1573	Corn,	12.48	7.05	76.83	1.56	2.08	1,990
1574	Corn,	11.00	6.91	78.61	1.53	1.95	1,985
1575	Corn,	11.42	7.43	77.57	1.54	2.04	1,995
1576	Corn,	12.19	7.05	77.25	1.49	2.02	1,990
1577	Soy beans,	35.17	19.81	28.18	3.23	13.61	2,075
1578	Soy beans,	39.31	20.17	27.90	3.27	9.35	2,165
1579	Soy beans,	35.10	22.37	31.96	3.37	7.20	2,255
1580	Soy beans,	38.05	21.34	30.57	3.52	6.52	2,240
1581	Soy beans,	36.95	21.71	30.53	3.25	7.56	2,230
1582	Soy beans,	39.29	21.44	29.90	3.26	6.11	2,250

TABLE 65.—*(Continued.)*

Lab. No.	Feeding Stuffs.	Protein.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Fuel Value Per Pound.
	Seeds.	%	%	%	%	%	Cal.
1583	Soy beans,	41.40	20.43	28.65	3.40	6.12	2,230
1584	Soy beans,	36.86	21.97	30.95	3.58	6.64	2,255
1585	Soy beans,	37.71	21.58	31.40	3.38	5.93	2,260
1586	Soy beans,	39.82	20.71	29.08	3.49	6.90	2,220
1587	Soy beans,	38.13	22.77	28.62	3.72	6.76	2,270
1378	Wheat,	15.12	2.10	79.56	1.66	1.56	1,880
1501	Wheat,	20.81	6.12	60.92	7.74	4.41	1,920
	Milling and By-Products.						
1381	Corn meal,	11.20	5.99	79.59	1.31	1.91	1,965
1388	Corn meal,	10.41	4.71	81.92	1.36	1.60	1,940
1406	Corn meal,	13.21	5.69	77.16	2.19	1.75	1,965
1502	Corn meal,	12.50	5.21	79.21	1.45	1.63	1,955
1391	Corn and cob meal,	11.62	4.38	79.87	2.72	1.41	1,940
1411	Corn and cob meal,	10.42	4.19	79.68	4.11	1.60	1,930
1424	Corn and cob meal,	11.51	4.30	76.67	5.94	1.58	1,930
1441	Corn and cob meal,	8.84	6.41	78.70	4.08	1.97	1,975
1442	Cotton seed meal,	28.60	9.85	48.75	5.11	7.69	1,950
1448	Cotton seed meal,	35.51	11.31	42.93	2.84	7.41	1,990
1434	Buffalo gluten meal,	29.77	17.07	45.15	7.02	.99	2,245
1449	Buffalo gluten meal,	30.36	17.07	44.68	6.72	1.17	2,240
1390	Imperial feed,	18.18	4.99	65.94	6.38	4.51	1,895
1413	Imperial feed,	19.19	4.99	62.82	7.36	5.64	1,875
1405	Malt sprouts,	29.69	3.15	46.73	12.96	7.47	1,795
1412	Old process linseed meal,	29.39	2.79	53.66	8.29	5.87	1,810
1439	Soy bean meal,	39.85	20.80	30.68	2.89	5.78	2,245
1440	Soy bean meal,	40.52	21.26	29.62	2.88	5.72	2,255
1379	Culled peas,	28.19	1.61	63.25	3.30	3.65	1,830
1382	Refuse from manufacture of split peas,	18.12	1.47	38.42	28.66	13.33	1,650
1380	Wheat bran,	19.55	5.46	61.16	8.35	5.48	1,885
1435	Wheat bran,	22.14	6.14	56.96	9.39	5.37	1,905
1443	Wheat bran,	19.09	5.23	61.90	8.56	5.22	1,885
1450	Wheat bran,	18.54	5.60	61.69	9.07	5.10	1,895
1387	Wheat middlings,	20.95	5.64	64.70	4.91	3.80	1,920
1407	Wheat middlings,	20.25	4.92	68.23	3.82	2.78	1,925

DIGESTION EXPERIMENTS WITH SHEEP.

BY C. S. PHELPS AND CHAS. D. WOODS.

It is a matter of every-day experience that only a part of the food eaten is actually used by the animal. It is, therefore, of importance in cattle feeding to have a knowledge, not only of the chemical composition of a given food, but of the amounts of the nutrients which are capable of being assimilated.

Partly to add to the stock of knowledge upon this important subject and partly because of the need of the results for use in connection with its feeding experiments, the Station began two years ago a series of digestion experiments with sheep.*

DIGESTION EXPERIMENTS — HOW CONDUCTED.

A digestion experiment is usually managed as follows: Selected animals are fed with the kind or kinds of feeding stuffs to be tested. The feeding stuffs are carefully analyzed. A weighed portion is fed, care being taken to see that none is wasted, and that all the uneaten residues are weighed and analyzed. In this way the exact weights of protein, fat, fiber, nitrogen-free extract and ash eaten are ascertained.* The solid excrement of the animals contains the undigested residues. This is carefully collected, dried, weighed and analyzed, and the amounts of undigested protein, fat, fiber, nitrogen-free extract and ash contained in it are found. The difference between the amounts found in the undigested residues and the amounts contained in the food eaten is taken as a measure of the amounts of the various nutrients which have been digested and assimilated by the animals.

While such an experiment seems comparatively simple, it is surrounded by a number of difficulties which make the work laborious and tend to make the results somewhat uncertain.

*See Report of this Station of 1894, pp. 107–134.

EXPERIMENTS HERE REPORTED.

From experiments made elsewhere it has been found that differences due to age, breed and species of ruminants are slight. The digestibility of a feed by a sheep can be taken as a tolerably correct measure of its digestibility by a cow or steer. As sheep are easier to experiment with than the larger animals, and as many of the feeding experiments by the Station are with sheep, they have been employed in the digestion experiments which are here reported upon.

The pens for the animals are similar to those devised by the Maine Experiment Station* except that the partitions and sides were made of half-inch iron pipe. The pen for each animal is about five feet square and has at one side a narrow stall in which the sheep is confined during the part of the experiment in which the feces are collected. The mangers are arranged so as to prevent loss of food by scattering. The rubber-lined bags for collecting the feces and the harness used to hold them in place are quite similar to those used by the Maine Station.

Each experiment lasted twelve days. The first seven days were given to preliminary feeding, during which the feces were not collected and each animal had the run of its pen. At the end of the first seven days the sheep were placed in the narrow stall and the rubber-lined bags for collecting the feces were attached. The whole of the feces was collected during the last five days of the experiment, and was removed twice daily from the bags and placed in the drying apparatus. Each half-day's portion of the feces was dried by itself, put in a glass jar and sent to the laboratory for analysis.

In connection with the digestion experiments with sheep, the heats of combustion of the feeding stuffs and feces were determined by use of the bomb calorimeter, with the purpose of getting light upon the potential energy or fuel value of the digested material.

Table 66, which immediately follows, gives a summary of the results of all the digestion experiments with sheep made by the Station. Experiments Nos. 1–9 were reported in the Annual Report of the Station for 1894. The detailed account of the other experiments (Nos. 10–27) will be found on pages 197–214, beyond.

*See Report of this Station, 1894, pp. 123, 124.

TABLE 66.

Summary of Results of Digestion Experiments with Sheep. Percentages of Total Nutrients and Fuel Value of the Different Feeding Stuffs Actually Digested.

Feeding Stuffs.	Expt. No.	Sheep.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.	Fuel Value.
Milling Products (with Hay).			%	%	%	%	%	%	%
Bran, corn meal and hay,*	1	B	48.0	60.6	71.5	45.6	5.9	62.7	57.6
Bran, corn meal and hay,	1	D	62.1	72.9	76.1	59.6	26.6	70.8	66.4
Bran, corn meal and hay,	4	B	57.6	69.1	80.1	60.7	32.0	72.8	67.9
Bran, corn meal and hay,	4	D	52.2	71.2	77.7	55.2	27.4	69.6	65.2
Average,	—	—	**55.0**	**68.5**	**76.4**	**55.3**	**23.0**	**69.0**	**64.3**
Bran, corn meal, linseed meal, oat and pea meal and hay,†	2	B	73.5	64.7	73.8	59.0	26.8	70.1	63.6
	2	D	71.2	71.2	74.9	60.8	28.2	70.9	64.8
Bran, corn meal, linseed meal, oat and pea meal and hay,	3	B	77.1	72.8	77.0	69.2	40.9	75.0	70.3
	3	D	71.6	73.4	73.6	61.1	20.9	70.3	65.4
Average,	—	—	**73.4**	**70.5**	**74.8**	**62.5**	**29.2**	**71.6**	**66.0**
Soy bean meal and timothy hay,	12	A	75.8	71.1	66.7	61.2	42.0	68.5	62.9
Soy bean meal and timothy hay,	12	B	77.0	76.7	69.0	61.2	51.6	70.5	65.9
Soy bean meal and timothy hay,	12	C	80.0	77.4	68.4	63.1	48.9	71.5	67.0
Soy bean meal and timothy hay,	12	E	76.0	71.4	60.9	56.7	51.1	65.4	61.3
Average,	—	—	**77.2**	**74.2**	**66.3**	**60.6**	**48.4**	**69.0**	**64.3**
Soy bean meal and timothy hay,	13	A	77.0	74.1	62.2	59.7	52.0	67.0	62.8
Soy bean meal and timothy hay,	13	B	77.4	73.3	66.5	63.1	36.8	69.5	64.0
Soy bean meal and timothy hay,	13	C	78.5	72.0	63.5	55.8	45.3	66.9	62.7
Soy bean meal and timothy hay,	13	E	80.0	73.1	71.8	69.5	48.6	73.7	68.7
Average,	—	—	**78.2**	**73.1**	**66.0**	**62.0**	**45.7**	**69.3**	**64.6**
Experiment 12, calculated for digestibility of soy bean meal above average,	—	—	85.1	86.6	73.6	—	26.3	77.5	72.2
Experiment 13, calculated for digestibility of soy bean meal above average,	—	—	86.6	83.2	73.1	—	16.2	78.4	72.7
Avg. of experiments 12 and 13, 8 tests, calculated for soy bean meal alone,	—	—	**85.8**	**84.9**	**73.4**	—	**21.3**	**78.0**	**72.5**
Cured Fodders and Hays.									
Rowen hay, mixed grasses, chiefly Kentucky blue grass	8	A	70.1	50.5	67.7	66.2	54.8	66.7	60.9
	8	B	67.6	44.0	62.9	65.4	49.4	63.5	57.1
Rowen hay, mixed grasses, chiefly Kentucky blue grass	8	C	70.2	45.6	62.6	66.1	55.5	64.1	58.1
	8	D	68.4	44.6	67.0	68.2	52.4	66.3	59.5
Average,	—	—	**69.1**	**46.2**	**65.1**	**66.5**	**53.0**	**65.2**	**58.9**
Rowen hay, mostly timothy,	9	A	66.1	50.8	64.9	65.2	50.8	64.4	59.3
Rowen hay, mostly timothy,	9	B	69.4	48.2	60.9	62.0	74.6	62.0	58.6
Rowen hay, mostly timothy,	9	C	68.2	48.7	63.5	65.2	53.2	64.1	58.3
Rowen hay, mostly timothy,	9	D	68.3	50.3	64.3	73.4	46.9	67.2	60.9
Average,	—	—	**68.0**	**49.5**	**63.4**	**66.5**	**56.4**	**64.4**	**59.3**
Scarlet clover hay, field cured,	10	A	67.8	49.2	59.4	39.8	48.4	52.9	48.3
Scarlet clover hay, field cured,	10	B	67.8	49.2	62.7	41.4	41.5	54.9	49.6
Scarlet clover hay, field cured,	10	C	68.9	45.9	57.3	46.4	46.8	54.8	50.3
Scarlet clover hay, field cured,	10	D	68.5	52.4	60.7	47.3	51.2	56.6	51.9
Average,	—	—	**68.3**	**49.2**	**60.0**	**43.8**	**47.0**	**54.8**	50.0

* The wide ration of sheep feeding experiments, pp. 92–106, Report of 1894.

† The narrow ration of sheep feeding experiments, pp. 92–106, Report of 1894.

TABLE 66.—*(Continued.)*

FEEDING STUFFS.	Expt. No.	Sheep.	Protein. N. × 6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.	Fuel Value.
Cured Fodders & Hays.—(Con.)			%	%	%	%	%	%	%
Scarlet clover hay, barn cured,	11	A	67.2	32.8	59.8	47.0	45.6	56.2	50.0
Scarlet clover hay, barn cured,	11	B	67.6	29.5	61.6	48.9	47.2	57.6	51.6
Scarlet clover hay, barn cured,	11	C	73.2	42.3	63.9	42.8	49.7	57.8	52.1
Average, - - - - -	—	—	**69.3**	**34.9**	**61.8**	**46.2**	**47.5**	**57.2**	**51.2**
Avg. field & barn cured (7 tests),	—	—	**68.7**	**43.0**	**60.8**	**44.8**	**47.2**	**55.8**	**50.5**
Green Fodders and Grasses.									
Scarlet clover fodder, - -	5	A	76.7	67.3	74.5	54.1	55.0	68.5	63.7
Scarlet clover fodder, - -	5	B	77.5	62.9	74.9	57.9	55.9	69.8	64.3
Scarlet clover fodder, - -	5	D	77.2	69.3	74.1	56.2	57.4	69.1	64.3
Average, - - - - -	—	—	**77.1**	**66.5**	**74.5**	**56.1**	**56.1**	**69.1**	**64.1**
Barley fodder, - - -	6	A	69.3	61.2	69.3	49.0	49.7	62.2	57.8
Barley fodder, - - -	6	B	71.4	63.1	76.3	63.6	62.2	70.7	66.4
Barley fodder, - - -	26	B	73.1	56.3	69.3	66.4	53.2	68.7	62.8
Barley fodder, - - -	26	F	73.1	58.9	69.9	64.0	52.5	68.4	62.7
Average, - - - - -	—	—	**71.7**	**59.9**	**71.2**	**60.7**	**54.4**	**67.5**	**62.4**
Barley and pea fodder, - -	7	C	81.1	64.8	67.0	49.3	58.4	65.1	60.2
Barley and pea fodder, - -	7	D	73.2	54.5	55.8	37.6	33.9	55.2	49.4
Average, - - - - -	—	—	**77.2**	**59.7**	**61.4**	**43.5**	**46.2**	**60.2**	**54.8**
Oat and pea fodder, - -	14	A	81.7	74.3	65.7	61.2	38.5	68.7	63.9
Oat and pea fodder, - -	14	B	81.3	72.8	67.1	53.7	23.9	67.1	62.4
Average, - - - - -	—	—	**81.5**	**73.6**	**66.4**	**57.5**	**31.2**	**67.9**	**63.2**
Oat fodder, - - - -	15	C	75.7	68.4	63.5	62.6	43.8	65.4	61.9
Oat fodder, - - - -	15	E	74.9	71.3	62.7	57.8	45.7	63.5	60.3
Average, - - - - -	—	—	**75.3**	**69.8**	**63.1**	**60.2**	**44.8**	**64.5**	**61.1**
Hungarian fodder, - - -	16	A	66.7	85.1	68.4	72.7	53.6	70.6	68.6
Hungarian fodder, - - -	16	B	71.8	81.9	71.7	76.1	62.9	73.8	71.3
Hungarian fodder, - - -	19	C	61.0	62.5	69.2	70.3	59.6	68.5	64.6
Hungarian fodder, - - -	19	D	61.6	59.8	66.3	72.2	57.8	67.6	63.6
Average, - - - - -	—	—	**65.3**	**72.3**	**68.9**	**72.8**	**58.5**	**70.1**	**67.0**
Soy bean fodder, - - -	17	C	80.5	58.2	70.9	44.7	1.8	64.5	61.2
Soy bean fodder, - - -	17	E	77.0	50.0	73.0	55.5	13.8	67.5	63.4
Soy bean fodder, - - -	20	B	70.8	59.3	71.7	38.5	27.6	61.0	56.1
Soy bean fodder, - - -	20	F	67.7	49.3	75.3	43.3	13.0	63.5	58.1
Average, - - - - -	—	—	**74.0**	**54.2**	**72.7**	**45.5**	**14.0**	**64.1**	**59.7**
Clover rowen, - - -	18	B	61.4	60.0	63.9	51.5	42.7	59.7	55.6
Clover rowen, - - -	18	F	62.3	61.5	66.7	53.6	44.1	61.9	57.3
Average, - - - - -	—	—	**61.9**	**60.8**	**65.3**	**52.5**	**43.4**	**60.8**	**56.5**
Sweet corn fodder, - - -	21	C	58.6	79.2	73.3	53.6	46.4	67.5	64.5
Sweet corn fodder, - - -	21	D	52.5	77.3	74.9	54.9	54.9	68.4	65.4
Sweet corn fodder, - - -	22	B	66.8	82.1	77.4	59.8	53.2	73.2	69.3
Sweet corn fodder, - - -	22	F	66.1	81.3	79.1	61.6	47.4	74.5	70.5
Sweet corn fodder, - - -	24	C	68.7	79.8	82.4	72.2	51.3	78.8	75.1
Sweet corn fodder, - - -	24	D	57.9	76.2	75.9	57.9	49.4	70.4	66.2
Average, - - - - -	—	—	**61.8**	**79.3**	**77.2**	**60.0**	**50.4**	**72.1**	**68.5**
Cow pea fodder, - - -	23	C	72.7	62.5	84.2	57.8	28.2	75.9	71.2
Cow pea fodder, - - -	23	D	75.3	56.3	84.2	57.1	19.5	76.0	70.9
Average, - - - - -	—	—	**74.0**	**59.4**	**84.2**	**57.5**	**23.9**	**76.0**	**71.1**
Rowen, mostly timothy, - -	25	B	71.9	54.8	67.3	60.0	43.9	65.3	58.8
Rowen, mostly timothy, - -	25	F	71.5	50.9	68.2	67.6	46.5	67.5	61.7
Average, - - - - -	—	—	**71.7**	**52.0**	**67.8**	**63.8**	**45.2**	**66.4**	**60.3**
Canada pea fodder, - -	27	C	81.1	50.0	71.3	62.4	37.8	71.0	64.3
Canada pea fodder, - -	27	D	83.0	54.8	70.8	62.4	46.9	71.7	65.0
Average, - - - - -	—	—	**82.0**	**52.4**	**71.0**	**62.4**	**42.3**	**71.3**	**64.7**

DETAILED DESCRIPTION OF EXPERIMENTS.

DIGESTION EXPERIMENT NO. 10*.

Scarlet Clover Hay, field cured.

Four sheep, A, B, C and D, wethers, dropped in the spring of 1883. A, C and D were grade Shropshires, and B was grade Merino. The experiment began December 26, 1894, and continued twelve days The feces were collected for the five days from January 2, 5 P. M., to January 7, 5 P. M. Each sheep was fed daily one and one-half pounds of the hay. The scarlet clover hay was cut June 4, 1894, and dried in cocks. At the time of cutting it was a little past full bloom, many of the heads beginning to seed at the base. The experiment was apparently normal with all four animals. They all ate their feed completely, and seemed to be hungry.

DIGESTION EXPERIMENT NO. 11.

Scarlet Clover Hay, barn cured.

Three sheep, A, B and C, of the preceding experiment. The experiment began January 19, 1895, and continued twelve days. The feces were collected for the five days from January 26, 4:30 P. M., to January 31, 4:30 P. M. A and B gnawed the platform slightly, A also ate some wool. Each sheep was fed daily one and one-half pounds of the hay.

The scarlet clover hay was cut May 28, 1894, and dried and cured in the barn. At the time of cutting it was in full bloom. The feces of C were collected for only four days but the results have been recalculated for five days to compare with A and B.

DIGESTION EXPERIMENT NO. 12.

Soy Bean Meal, with timothy rowen.

Three sheep, A, B, C, of preceding experiments, and E, a new sheep in place of D. E was a grade Shropshire dropped in the spring of 1893. The experiment began February 2, 1895, and continued twelve days. The feces were collected for the five days from February 9, 5 P. M., to February 14, 5 P. M. The experiment was commenced with sheep D, but after one day, sheep E was substituted. All of the sheep ate their rations greedily, and seemed to be hungry. At the end of the experiment it was observed that sheep A had pulled some wool

* Reprinted from 1894 Report on account of error in weight of food eaten.

from its left side which was probably eaten, and which probably accounts for the large amount of ash in its feces. Each sheep was fed daily one-half pound soy bean meal, and one pound of timothy rowen.

DIGESTION EXPERIMENT NO. 13.

Soy Bean Meal, with timothy rowen.

This experiment was a duplicate of No. 12, with the same animals and the same feed, but in different proportions. The experiment began February 16, 1895, and continued twelve days. The feces were collected for the five days from February 23, 5 P. M., to February 28, 5 P. M. The animals ate the rations completely with the exception that the last three days C and E left a little uneaten residue. Each sheep was fed daily three-fourths pound soy bean meal and one and one-half pounds timothy rowen.

DIGESTION EXPERIMENT NO. 14.

Oats and Peas, fed green.

This and the following experiments with green fodders were made particularly to test the digestibility of fodders used in feeding tests with milch cows. The general plan was to feed three or four days without sampling, then three or four days taking sample 1, then five days taking sample 2. This had at times to be modified to meet various conditions, as particularly, weather.

Animals, sheep A and B, of preceding experiments. The experiment began July 6, 1895, and continued fourteen days. The feces were collected for the five days from July 15, 11 A. M., to July 20, 11 A. M. Each sheep was fed daily six pounds of oat and pea fodder. Both animals went through the experiment nicely. A left a little uneaten the last day.

DIGESTION EXPERIMENT NO. 15.

Oat Fodder, fed green.

Two sheep, C and D, of the preceding experiments. The experiment began July 6, 1895, and continued fourteen days. The feces were collected for the five days from July 15, 11 A. M., to July 20, 11 A. M. Each sheep was fed daily six pounds of the oat fodder, and went through the experiment nicely.

DIGESTION EXPERIMENT NO. 16.

Hungarian Grass, fed green.

Two sheep, A and B, of the preceding experiments. The experiment began July 27, 1895, and continued fourteen days. The feces were collected for the five days from August 5, 6:30 P. M., to August 10, 6:30 P. M. Each sheep was fed daily six pounds of the fodder. Sheep A left some uneaten residue.

DIGESTION EXPERIMENT NO. 17.

Soy Bean Fodder, fed green.

Two sheep, C and E, of the preceding experiments. The experiment began July 27, 1895, and continued fourteen days. The feces were collected for the five days from August 5, 6:30 P. M., to August 10, 6:30 P. M. Each sheep was fed daily six pounds of the fodder.

DIGESTION EXPERIMENT NO. 18.

Clover Rowen, fed green.

Two sheep—B, of the preceding experiments and F, a grade Shropshire dropped in spring of 1893. The experiment began August 10, 1895, and continued fourteen days. The feces were collected for the five days from August 19, 6:30 A. M., to August 24, 6:30 A. M. Each animal was fed daily for the first three days seven pounds, and afterwards six pounds, ten ounces, daily.

Two samples of clover rowen were cut, the first August 15. The clover averaged a little past full bloom. About one-tenth of the rowen was composed of grasses, mostly timothy. The second sample was cut August 19, when the clover was about half in bloom, and half in the early seed stage with heads drying, the average being past full bloom.

DIGESTION EXPERIMENT NO. 19.

Hungarian Grass, fed green.

This is a duplicate of No. 16, using different animals—two sheep, C and D, of the preceding experiments. The experiment began August 10, 1895, and continued fourteen days. The feces were collected for the five days, from August 19, 6:30 A. M., to August 24, 6:30 A. M. From August 10 to August 12 each animal was fed seven pounds daily; August 13 and 14, six pounds, ten ounces daily, and the remainder of the period six pounds, three ounces daily.

Two samples of the grass were taken. The first, cut August 15, a little past full bloom, somewhat more woody than that in experiment 16. The second cut August 19, mostly in early seed stage, stems quite woody.

DIGESTION EXPERIMENT NO. 20.

Soy Bean Fodder, fed green.

This experiment is similar to experiment No. 17, using different animals, with the exception the soy beans were more advanced. Two sheep, B and F, of the preceding experiments. The experiment began August 24, 1895, and continued twelve days. Each animal was fed daily six pounds, three ounces of the fodder.

Two samples were taken, the first cut August 28. The seeds were beginning to form, and the stems quite hard. The second sample was cut August 31. The pods were generally formed, the seeds about half grown in the more advanced pods. There was a heavy growth of fodder, and stems were quite hard. The sheep ate the fodder completely.

DIGESTION EXPERIMENT NO. 21.

Sweet Corn Fodder, fed green.

Two sheep, C and D, of the preceding experiments. The experiment began August 24, 1895, and continued twelve days. The feces were collected for the five days from August 31, 6:30 A. M., to September 5, 6:30 A. M.

Each animal was fed daily six pounds, three ounces. Two samples of the fodder were taken. The first August 28, when the ears were in the roasting stage, many not full grown. The second sample was cut August 31, when most of the stalks were eared, but with many small ears. The ears were in good condition for cooking. On September 1 both sheep began to leave butts of corn fodder uneaten.

DIGESTION EXPERIMENT NO. 22.

Sweet Corn Fodder, fed green.

This experiment is similar to No. 21, using different animals. Two sheep, B and F, of the preceding experiments. The experiment began September 9, 1895, and continued twelve days. The feces were collected for the five days from September 16, 6:30 A. M., to September 21, 6:30 A. M. Each animal was fed daily six pounds, three ounces of the fodder.

Two samples were taken. The first was cut September 12, when the corn was in the early roasting stage, and not fully grown on many ears. The second sample was cut September 16. The stalks and leaves were getting yellow and drying in many places, and the corn was a little old for cooking.

DIGESTION EXPERIMENT NO. 23.

Cow Pea Fodder, fed green.

Two sheep, C and D, of preceding experiments. The experiment began September 9, 1895, and continued twelve days. The feces were collected for the five days from September 16, 6:30 A. M., to September 21, 6:30 A. M. Each animal was fed daily six pounds, three ounces of the fodder.

Two samples were taken. The first was cut September 12. The cow peas, of medium heavy growth, were not quite fully grown, and all space between the rows was not covered. The second sample was cut September 16. The condition of the peas was the same as in the first sample. There were no runners. Sheep C, feces very soft the morning of the 17th, and continued soft during the remainder of the test.

DIGESTION EXPERIMENT NO. 24.

Sweet Corn Fodder, fed green.

This experiment is similar to Nos. 21 and 22. Two sheep, C and D, of experiment No. 21. The experiment began September 21, and continued twelve days for C and thirteen days for D. The feces of C were collected for the five days from September 28, 6:30 A. M., to October 3, 6:30 A. M. Those of D for the five days from September 29, 6:30 A. M., to October 4, 6:30 A. M.

Each animal was fed daily six pounds, three ounces of the fodder. Two samples of the corn fodder ("Branching Sweet" variety) were taken. The first was cut September 24. The corn and leaves were green and succulent, and most of the stalks had ears which were in early roasting stage. The second sample was cut September 28. The corn was in the roasting stage, and the leaves still quite green and succulent.

DIGESTION EXPERIMENT NO. 25.

Rowen Grass, fed green.

Two sheep, B and F, of the preceding experiments. The experiment began September 28, 1895, and continued twelve

days. The feces were collected for the five days from October 5, 6:30 A. M., to October 10, 6:30 A. M. Each animal was fed daily six pounds, three ounces, till October 1, after which they were fed five and one-fourth pounds daily.

Two samples of the rowen were taken. The first sample was cut October 1, and consisted mostly of timothy, about two-thirds grown, with a little clover and some fine grasses. Rowen as a whole not very succulent. The second sample was cut October 5, and was similar to the first sample.

DIGESTION EXPERIMENT NO. 26.

Barley Fodder (from barley and peas), fed green.

Sheep B and F, of the preceding experiments. The experiment began October 12, 1895, and continued twelve days. The feces were collected for the five days from October 19, 6:30 A. M., to October 24, 6:30 A. M.

Each sheep was fed daily six pounds, three ounces of the fodder. Both sheep ate all their food and went through the experiment nicely. The first sample was cut October 15 from field of barley and peas. The barley was green and succulent, heads about three-fourths grown. The barley was separated from the peas, and the latter were used for digestion experiment No. 27. The barley was about 47 per cent. of the whole. The second sample was cut October 19, heads nearly full grown, stems quite succulent, no bloom.

DIGESTION EXPERIMENT NO. 27.

Canada Pea Fodder (from barley and peas), fed green.

Sheep C and D, of the preceding experiments. The experiment began October 12, 1895, and continued twelve days. The feces were collected for the five days from October 19, 6:30 A. M., to October 24, 6:30 A. M.

Each animal was fed daily six pounds, three ounces of fodder. The first sample was cut October 15 from same field of barley and peas as experiment No. 26. The peas were separated from the barley, forming about 57 per cent. of the whole. Peas quite large, but no blossoms; about three-fourths grown. The second sample was cut October 19th. Peas tender and succulent, quite large, but no blossoms. The experiment was normal throughout, with the exception that sheep D was by mistake fed one ration of barley fodder on the 21st.

DIGESTION EXPERIMENT No. 10.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water.	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1418	Scarlet clover hay,* -	13.9	14.1	1.8	31.6	31.3	7.3	78.8	3.766
	Feces.								
1419	Sheep A, - - -	5.4	10.5	2.1	29.7	43.6	8.7	85.9	4.309
1420	Sheep B, - - -	6.9	10.6	2.1	27.6	42.8	10.0	83.1	4.245
1421	Sheep C, - - -	6.3	10.4	2.3	32.0	39.8	9.2	84.5	4.248
1422	Sheep D, - - -	5.5	11.1	2.1	31.1	41.3	8.9	85.6	4.329

* Field cured.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in 5 Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, - - -	3,400	479	61	1,075	1,064	248	2,679
Sheep B, - - -	3,400	479	61	1,075	1,064	248	2,679
Sheep C, - - -	3,400	479	61	1,075	1,064	248	2,679
Sheep D, - - -	3,400	479	61	1,075	1,064	248	2,679
Feces for 5 Days.							
Sheep A, - - -	1,469	154	31	436	641	128	1,262
Sheep B, - - -	1,455	154	31	401	623	145	1,209
Sheep C, - - -	1,433	149	33	459	570	132	1,211
Sheep D, - - -	1,359	151	29	422	561	121	1,163
Amounts Digested.							
Sheep A, - - -	—	325	30	639	423	120	1,417
Sheep B, - - -	—	325	30	674	441	103	1,470
Sheep C, - - -	—	330	28	616	494	116	1,468
Sheep D, - - -	—	328	32	653	503	127	1,516
Percentage Digested.		%	%	%	%	%	%
Sheep A, - - -	—	67.8	49.2	59.4	39.8	48.4	52.9
Sheep B, - - -	—	67.8	49.2	62.7	41.4	41.5	54.9
Sheep C, - - -	—	68.9	45.9	57.3	46.4	46.8	54.8
Sheep D, - - -	—	68.5	52.4	60.7	47.3	51.2	56.6
Average, - - -	—	**68.3**	**49.2**	**60.0**	**43.8**	**47.0**	**54.8**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - - -	12,805	6,330	6,475	285	6,190	48.3
Sheep B, - - -	12,805	6,175	6,630	285	6,345	49.6
Sheep C, - - -	12,805	6,085	6,720	285	6,435	50.3
Sheep D, - - -	12,805	5,880	6,925	285	6,640	51.9
Average, - - -	—	—	—	—	—	**50.0**

DIGESTION EXPERIMENT No. 11.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1432	Scarlet clover hay,*	19.6	15.5	1.9	29.7	25.9	7.3	73.0	3.526
	Feces.								
1429	Sheep A, - -	6.5	13.2	3.1	31.2	35.7	10.3	83.2	4.342
1430	Sheep B, - -	6.3	13.5	3.4	30.8	35.6	10.4	83.3	4.345
1431	Sheep C, - -	6.6	11.2	3.0	29.1	40.1	10.0	83.4	4.305

* Barn cured.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, - - -	3,400	527	61	1,016	881	248	2,485
Sheep B, - - -	3,400	527	61	1,016	881	248	2,485
Sheep C, - - -	3,400	527	61	1,016	881	248	2,485
Feces for Five Days.							
Sheep A, - - -	1,309	173	41	408	467	135	1,089
Sheep B, - - -	1,265	171	43	390	450	131	1,054
Sheep C, - - -	1,256	141	37	365	504	125	1,047
Amounts Digested.							
Sheep A, - - -	—	354	20	608	414	113	1,396
Sheep B, - - -	—	356	18	626	431	117	1,431
Sheep C, - - -	—	386	24	651	377	123	1,438
Percentage Digested.	%	%	%	%	%	%	%
Sheep A, - - -	—	67.2	32.8	59.8	47.0	45.6	56.2
Sheep B, - - -	—	67.6	29.5	61.6	48.9	47.2	57.6
Sheep C, - - -	—	73.2	42.3	63.9	42.8	49.7	57.8
Average, - -	—	**69.3**	**34.9**	**61.8**	**46.2**	**47.5**	**57.2**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - -	11,988	5,684	6,304	308	5,996	50.0
Sheep B, - -	11,988	5,496	6,492	308	6,184	51.6
Sheep C, - -	11,988	5,409	6,579	336	6,243	52.1
Average, - -	—	—	—	—	—	**51.2**

DIGESTION EXPERIMENT No. 12.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.*
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
1439	Soy bean meal, -	10.7	35.6	18.6	27.4	2.6	5.1	84.2	5.046
1433	Timothy rowen hay,	13.5	15.2	4.7	36.0	23.5	7.1	79.4	3.986
	Feces.								
1454	Sheep A, - -	6.5	17.0	8.6	35.4	20.6	11.9	81.6	4.690
1455	Sheep B, - -	6.0	17.6	7.6	35.6	22.4	10.8	83.2	4.636
1456	Sheep C, - -	6.3	15.6	7.5	37.2	21.7	11.7	82.0	4.530
1457	Sheep E, - -	4.5	16.2	8.2	39.6	21.9	9.6	85.9	4.689

* Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, - - -	3,405	749	318	1,128	564	219	2,759
Sheep B, - - -	3,405	749	318	1,128	564	219	2,759
Sheep C, - - -	3,405	749	318	1,128	564	219	2,759
Sheep E, - - -	3,405	749	318	1,128	564	219	2,759
Feces for Five Days.							
Sheep A, - - -	1,064	181	92	376	219	127	868
Sheep B, - - -	979	172	74	350	219	106	815
Sheep C, - - -	960	150	72	357	208	112	787
Sheep E, - - -	1,113	180	91	441	244	107	956
Amounts Digested.							
Sheep A, - - -	—	568	226	752	345	92	1,891
Sheep B, - - -	—	577	244	778	345	113	1,944
Sheep C, - - -	—	599	246	771	356	107	1,972
Sheep E, - - -	—	569	227	687	320	112	1,803
Percentage Digested.		%	%	%	%	%	%
Sheep A, - - -	—	75.8	71.1	66.7	61.2	42.0	68.5
Sheep B, - - -	—	77.0	76.7	69.0	61.2	51.6	70.5
Sheep C, - - -	—	80.0	77.4	68.4	63.1	48.9	71.5
Sheep E, - - -	—	76.0	71.4	60.9	56.7	51.1	65.4
Average, - -	—	**77.2**	**74.2**	**66.3**	**60.6**	**48.4**	**69.0**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - -	14,775	4,990	9,785	494	9,291	62.9
Sheep B, - -	14,775	4,539	10,236	502	9,734	65.9
Sheep C, - -	14,775	4,349	10,426	521	9,905	67.0
Sheep E, - -	14,775	5,219	9,556	494	9,062	61.3
Average, - -	—	—	—	—	—	**64.3**

DIGESTION EXPERIMENT No. 13.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N. × 6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.*
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
1440	Soy bean meal, -	10.1	36.4	19.1	26.6	2.6	5.2	84.7	5.121
1438	Timothy rowen hay,	13.2	14.9	4.1	36.1	24.6	7.1	79.7	3.976
	Feces.								
1458	Sheep A, - -	6.2	15.9	7.4	39.0	21.8	9.7	84.1	4.614
1459	Sheep B, - -	7.0	16.1	7.8	35.5	20.5	13.1	79.9	4.575
1460	Sheep C, - -	6.9	14.5	7.8	36.7	23.3	10.8	82.3	4.505
1461	Sheep E, - -	5.8	16.8	9.3	35.4	20.1	12.6	81.6	4.606

* Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N. × 6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, - - -	5,100	1,126	464	1,679	881	329	4,150
Sheep B, - - -	5,100	1,126	464	1,679	881	329	4,150
Sheep C, - - -	5,100	1,126	464	1,679	881	329	4,150
Sheep E, - - -	5,100	1,126	464	1,679	881	329	4,150
Feces for Five Days.							
Sheep A, - - -	1,626	259	120	634	355	158	1,368
Sheep B, - - -	1,585	255	124	563	325	208	1,267
Sheep C, - - -	1,669	242	130	613	389	180	1,374
Sheep E, - - -	1,339	225	125	474	269	169	1,093
Amounts Digested.							
Sheep A, - - -	—	867	344	1,045	526	171	2,782
Sheep B, - - -	—	871	340	1,116	556	121	2,883
Sheep C, - - -	—	884	334	1,066	492	149	2,776
Sheep E, - - -	—	901	339	1,205	612	160	3,057
Percentage Digested.		%	%	%	%	%	%
Sheep A, - - -	—	77.0	74.1	62.2	59.7	52.0	67.0
Sheep B, - - -	—	77.4	73.3	66.5	63.1	36.8	69.5
Sheep C, - - -	—	78.5	72.0	63.5	55.8	45.3	66.9
Sheep E, - - -	—	80.0	73.1	71.8	69.5	48.6	73.7
Average, - -	—	**78.2**	**73.1**	**66.0**	**62.0**	**45.7**	**69.3**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - -	22,224	7,503	14,721	754	13,967	62.8
Sheep B, - -	22,224	7,251	14,973	758	14,215	64.0
Sheep C, - -	22,224	7,519	14,705	769	13,936	62.7
Sheep E, - -	22,224	6,167	16,057	784	15,273	68.7
Average, - -	—	—	—	—	—	**64.6**

DIGESTION EXPERIMENT No. 14.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Oat & pea fodder*—								
1468	Sample 1, - -	84.5	3.2	1.0	6.1	3.6	1.6	13.9	.710
1469	Sample 2, - -	83.3	3.4	1.0	6.5	4.1	1.7	15.0	.768
	Average, -	**83.9**	**3.3**	**1.0**	**6.3**	**3.9**	**1.6**	**14.5**	**.739**
	Feces.								
1477	Sheep A, - -	7.0	10.2	4.3	36.4	25.6	16.6	76.4	4.097
1478	Sheep B, - -	6.2	9.7	4.2	32.5	28.3	19.1	74.7	3.982

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, - - -	13,605	449	136	857	531	218	1,973
Sheep B, - - -	13,605	449	136	857	531	218	1,973
Feces for Five Days.							
Sheep A, - - -	807	82	35	294	206	134	617
Sheep B, - - -	869	84	37	282	246	166	649
Amounts Digested.							
Sheep A, - - -	—	367	101	563	325	84	1,356
Sheep B, - - -	—	365	99	575	285	52	1,324
Percentage Digested.		%	%	%	%	%	%
Sheep A, - - -	—	81.7	74.3	65.7	61.2	38.5	68.7
Sheep B, - - -	—	81.3	72.8	67.1	53.7	23.9	67.1
Average, - -	—	**81.5**	**73.6**	**66.4**	**57.5**	**31.2**	**67.9**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - -	10,054	3,306	6,748	319	6,429	63.9
Sheep B, - -	10,054	3,460	6,594	317	6,277	62.4
Average, - -	—	—	—	—	—	**63.2**

DIGESTION EXPERIMENT No. 15.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Oat fodder*—								
1470	Sample 1, - -	81.7	2.8	1.1	7.8	4.7	1.9	16.4	.840
1471	Sample 2, - -	78.9	2.6	.9	9.6	6.1	1.9	19.2	.966
	Average, -	**80.3**	**2.7**	**1.0**	**8.7**	**5.4**	**1.9**	**17.8**	**.903**
	Feces.								
1479	Sheep C, - -	7.0	8.4	4.1	40.8	26.0	13.7	79.3	4.197
1480	Sheep E, - -	6.4	8.4	3.6	40.4	28.4	12.8	80.8	4.242

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C, - - -	13,605	367	136	1,184	735	258	2,422
Sheep E, - - -	13,605	367	136	1,184	735	258	2,422
Feces for Five Days.							
Sheep C, - - -	1,058	89	43	432	275	145	839
Sheep E, - - -	1,093	92	39	442	310	140	883
Amounts Digested.							
Sheep C, - - -	—	278	93	752	460	113	1,583
Sheep E, - - -	—	275	97	742	425	118	1,539
Percentage Digested.		%	%	%	%	%	%
Sheep C, - - -	—	75.7	68.4	63.5	62.6	43.8	65.4
Sheep E, - - -	—	74.9	71.3	62.7	57.8	45.7	63.5
Average, - -	—	**75.3**	**69.8**	**63.1**	**60.2**	**44.8**	**64.5**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C, - -	12,285	4,440	7,845	242	7,603	61.9
Sheep E, - -	12,285	4,637	7,648	239	7,409	60.3
Average, - -	—	—	—	—	—	**61.1**

DIGESTION EXPERIMENT No. 16.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Hungarian grass*—								
1472	Sample 1, - -	78.5	2.6	2.1	9.1	5.7	2.0	19.5	1.028
1473	Sample 2, - -	78.7	2.6	.8	9.5	6.1	2.2	19.0	.949
	Average, -	**78.6**	**2.6**	**1.5**	**9.3**	**5.9**	**2.1**	**19.3**	**.989**
	Feces.								
1481	Sheep A, - -	5.5	12.8	3.4	42.5	22.8	13.0	81.5	4.269
1482	Sheep B, - -	4.4	12.0	4.5	43.2	23.1	12.8	82.8	4.381
	Uneaten Residue.								
1511	Sheep A, - -	4.8	6.0	1.1	40.7	29.7	17.7	77.5	3.536

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, fed, - -	13,605	354	204	1,265	803	286	2,626
Uneaten residue, A, -	202	12	2	82	60	36	156
Actually eaten, A,-	13,403	342	202	1,183	743	250	2,470
Sheep B, - - -	13,605	354	204	1,265	803	286	2,626
Feces for Five Days.							
Sheep A, - - -	891	114	30	379	203	116	726
Sheep B, - - -	830	100	37	358	192	106	687
Amounts Digested.							
Sheep A, - - -	—	228	172	804	540	134	1,744
Sheep B, - - -	—	254	167	907	611	180	1,939
Percentage Digested.		%	%	%	%	%	%
Sheep A, - - -	—	66.7	85.1	68.4	72.7	53.6	70.6
Sheep B, - - -	—	71.8	81.9	71.7	76.1	62.9	73.8
Average, - -	—	**69.3**	**83.5**	**70.0**	**74.4**	**58.3**	**72.2**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - -	12,741	3,804	8,937	198	8,739	68.6
Sheep B, - -	13,455	3,636	9,819	221	9,598	71.3
Average, - -	—	—	—	—	—	**70.0**

DIGESTION EXPERIMENT No. 17.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N. × 6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Soy bean fodder*—								
1474	Sample 1, - -	80.9	3.5	.7	7.6	5.2	2.1	17.0	.866
1475	Sample 2, - -	76.9	4.1	1.0	9.3	5.8	2.9	20.2	1.031
	Average, -	**78.9**	**3.8**	**.9**	**8.4**	**5.5**	**2.5**	**18.6**	**.949**
	Feces.								
1843	Sheep C, - -	3.7	7.9	4.0	26.0	32.3	26.1	70.2	3.628
1484	Sheep E, - -	3.8	10.3	5.3	26.6	28.7	25.3	70.9	3.775

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N. × 6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C, - - -	13,605	517	122	1,144	748	340	2,531
Sheep E, - - -	13,605	517	122	1,144	748	340	2,531
Feces for Five Days.							
Sheep C, - - -	1,281	101	51	333	414	334	899
Sheep E, - - -	1,160	119	61	309	333	293	822
Amounts Digested.							
Sheep C, - - -	—	416	71	811	334	6	1,632
Sheep E, - - -	—	398	61	835	415	47	1,709
Percentage Digested.		%	%	%	%	%	%
Sheep C, - - -	—	80.5	58.2	70.9	44.7	1.8	64.5
Sheep E, - - -	—	77.0	50.0	73.0	55.5	13.8	67.5
Average, - -	—	**78.8**	**54.1**	**72.0**	**50.1**	**7.8**	**66.0**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C, - -	12,911	4,647	8,264	362	7,902	61.2
Sheep E, - -	12,911	4,379	8,532	346	8,186	63.4
Average, - -	—	—	—	—	—	**62.3**

DIGESTION EXPERIMENT No. 18.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Clover rowen*—								
1512	Sample 1, - -	76.8	3.9	1.1	10.0	6.1	2.1	21.1	1.053
1513	Sample 2, - -	71.9	4.8	1.4	12.2	7.3	2.4	25.7	1.284
	Average, -	**74.4**	**4.3**	**1.3**	**11.1**	**6.7**	**2.2**	**23.4**	**1.169**
	Feces.								
1503	Sheep B, - -	5.2	14.7	4.6	35.5	28.8	11.2	83.6	4.418
1504	Sheep F, - -	5.0	15.2	4.7	34.7	29.1	11.3	83.7	4.462

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep B, - - -	15,000	645	195	1,665	1,005	330	3,510
Sheep F, - - -	15,000	645	195	1,665	1,005	330	3,510
Feces for Five Days.							
Sheep B, - - -	1,692	249	78	601	487	189	1,415
Sheep F, - - -	1,600	243	75	555	466	181	1,339
Amounts Digested.							
Sheep B, - - -	—	396	117	1,064	518	141	2,095
Sheep F, - - -	—	402	120	1,110	539	149	2,171
Percentage Digested.		%	%	%	%	%	%
Sheep B, - - -	—	61.4	60.0	63.9	51.5	42.7	59.7
Sheep F, - - -	—	62.3	61.5	66.7	53.6	44.1	61.9
Average, - -	—	**61.9**	**60.8**	**65.3**	**52.5**	**43.4**	**60.8**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep B, - -	17,535	7,475	10,060	315	9,745	55.6
Sheep F, - -	17,535	7,139	10,396	350	10,046	57.3
Average, - -	—	—	—	—	—	**56.5**

DIGESTION EXPERIMENT No. 19.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N. × 6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Hungarian grass*—								
1514	Sample 1, - -	71.3	2.7	.9	13.8	8.9	2.4	26.3	1.238
1515	Sample 2, - -	76.3	2.1	.8	11.3	7.3	2.2	21.5	1.023
	Average, -	**73.8**	**2.4**	**.8**	**12.6**	**8.1**	**2.3**	**23.9**	**1.131**
	Feces.								
1505	Sheep C, - -	4.5	10.6	3.4	43.8	27.2	10.5	85.0	4.374
1506	Sheep D, - -	4.7	10.1	3.5	46.5	24.6	10.6	84.7	4.365

* Fed green.

† Per gram as determined by calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N. × 6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams	Grams.
Sheep C, - - -	14,000	336	112	1,764	1,134	322	3,346
Sheep D, - - -	14,000	336	112	1,764	1,134	322	3,346
Feces for Five Days.							
Sheep C, - - -	1,240	131	42	544	337	130	1,054
Sheep D, - - -	1,280	129	45	595	315	136	1,084
Amounts Digested.							
Sheep C, - - -	—	205	70	1,220	797	192	2,292
Sheep D, - - -	—	207	67	1,169	819	186	2,262
Percentage Digested.		%	%	%	%	%	%
Sheep C, - - -	—	61.0	62.5	69.2	70.3	59.6	68.5
Sheep D, - - -	—	61.6	59.8	66.3	72.2	57.8	67.6
Average, - -	—	**61.3**	**61.2**	**67.8**	**71.3**	**58.7**	**68.0**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C, - -	15,834	5,424	10,410	178	10,232	64.6
Sheep D, - -	15,834	5,587	10,247	180	10,067	63.6
Average, - -	—	—	—	—	—	**64.1**

DIGESTION EXPERIMENT No. 20.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Soy bean fodder*—								
1516	Sample 1, - -	75.4	3.3	1.0	11.7	6.4	2.2	22.4	1.081
1517	Sample 2, - -	74.2	3.2	1.0	11.9	7.5	2.2	23.6	1.125
	Average, -	**74.8**	**3.3**	**1.0**	**11.8**	**6.9**	**2.2**	**23.0**	**1.105**
	Feces.								
1507	Sheep B, - -	3.4	8.8	3.7	30.6	38.9	14.6	82.0	4.258
1508	Sheep F, - -	4.1	9.9	4.7	27.1	36.4	17.8	78.1	4.121

* Fed green. † Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep B, - - -	14,000	462	140	1,652	966	308	3,220
Sheep F, - - -	14,000	462	140	1,652	966	308	3,220
Feces for Five Days.							
Sheep B, - - -	1,529	135	57	468	594	223	1,254
Sheep F, - - -	1,506	149	71	408	548	268	1,176
Amounts Digested.							
Sheep B, - - -	—	327	83	1,184	372	85	1,966
Sheep F, - - -	—	313	69	1,244	418	40	2,044
Percentage Digested.		%	%	%	%	%	%
Sheep B, - - -	—	70.8	59.3	71.7	38.5	27.6	61.0
Sheep F, - - -	—	67.7	49.3	75.3	43.3	13.0	63.5
Average, - -	—	**69.3**	**54.3**	**73.5**	**40.9**	**20.3**	**62.3**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep B, - -	15,470	6,511	8,959	284	8,675	56.1
Sheep F, - -	15,470	6,206	9,264	272	8,992	58.1
Average, - -	—	—	—	—	—	**57.1**

DIGESTION EXPERIMENT No. 21.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Sweet corn fodder*–								
1518	Sample 1, - -	80.4	1.8	.6	11.5	4.4	1.3	18.3	.854
1519	Sample 2, - -	78.4	1.6	.5	13.6	4.7	1.2	20.4	.939
	Average, -	**79.4**	**1.7**	**.6**	**12.5**	**4.5**	**1.3**	**19.3**	**.897**
	Feces.								
1509	Sheep C, - -	4.3	10.5	1.8	44.9	28.5	10.0	85.7	4.255
1510	Sheep D, - -	4.0	11.1	2.0	45.2	29.1	8.6	87.4	4.372
	Uneaten Residue.								
1520	Sheep C, - -	4.8	3.1	2.0	65.1	21.1	3.9	91.3	4.051
1521	Sheep D, - -	4.3	10.9	2.7	56.0	20.7	5.4	90.3	3.997

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C & D, fed each,	14,000	238	84	1,750	630	182	2,702
Uneaten residue, C, -	369	11	7	241	78	14	337
Uneaten residue, D, -	332	36	9	186	69	18	300
Actually eaten, C, -	13,631	227	77	1,509	552	168	2,365
Actually eaten, D, -	13,668	202	75	1,564	561	164	2,402
Feces for Five Days.							
Sheep C, - - -	897	94	16	403	256	90	769
Sheep D, - - -	868	96	17	393	253	74	759
Amounts Digested.							
Sheep C, - - -	—	133	61	1,106	296	78	1,596
Sheep D, - - -	—	106	58	1,171	308	90	1,643
Percentage Digested.		%	%	%	%	%	%
Sheep C, - - -	—	58.6	79.2	73.3	53.6	46.4	67.5
Sheep D, - - -	—	52.5	77.3	74.9	54.9	54.9	68.4
Average, - -	—	**55.5**	**78.3**	**74.1**	**54.3**	**50.7**	**68.0**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C, - -	11,064	3,817	7,247	116	7,131	64.5
Sheep D, - -	11,232	3,795	7,437	92	7,345	65.4
Average, - -	—	—	—	—	—	**65.0**

DIGESTION EXPERIMENT No. 22.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Sweet corn fodder*–								
1497	Sample 1, - -	78.6	2.0	.8	13.0	4.4	1.2	20.2	.952
1498	Sample 2, - -	78.0	1.9	.9	14.6	3.6	1.0	21.0	.970
	Average, -	**78.3**	**2.0**	**.8**	**13.8**	**4.0**	**1.1**	**20.6**	**.961**
	Feces.								
1523	Sheep B, - -	4.8	10.5	2.3	49.0	25.3	8.1	87.1	4.455
1522	Sheep F, - -	4.0	11.2	2.5	47.5	25.3	9.5	86.5	4.484

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep B, - - -	14,000	280	112	1,932	560	154	2,884
Sheep F, - - -	14,000	280	112	1,932	560	154	2,884
Feces for Five Days.							
Sheep B, - - -	889	93	20	436	225	72	774
Sheep F, - - -	850	95	21	404	215	81	735
Amounts Digested.							
Sheep B, - - -	—	187	92	1,496	335	82	2,110
Sheep F, - - -	—	185	91	1,528	345	73	2,149
Percentage Digested.		%	%	%	%	%	%
Sheep B, - - -	—	66.8	82.1	77.4	59.8	53.2	73.2
Sheep F, - - -	—	66.1	81.3	79.1	61.6	47.4	74.5
Average, - -	—	**66.5**	**81.7**	**78.3**	**60.7**	**50.3**	**73.9**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep B, - -	13,454	3,961	9,493	163	9,330	69.3
Sheep F, - -	13,454	3,811	9,643	161	9,482	70.5
Average, - -	—	—	—	—	—	**69.9**

DIGESTION EXPERIMENT No. 23.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N. × 6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Cow pea fodder*—								
1499	Sample 1, - -	79.8	3.4	.9	10.2	3.4	2.3	17.9	.852
1500	Sample 2, - -	80.2	3.2	.8	10.2	3.5	2.1	17.7	.852
	Average, -	**80.0**	**3.3**	**.8**	**10.2**	**3.5**	**2.2**	**17.8**	**.852**
	Feces.								
1524	Sheep C, - -	4.4	14.6	4.8	26.4	24.1	25.7	69.9	3.656
1525	Sheep D, - -	4.3	12.9	5.5	25.5	23.7	28.1	67.6	3.590

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N. × 6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C, - - -	14,000	462	112	1,428	490	308	2,492
Sheep D, - - -	14,000	462	112	1,428	490	308	2,492
Feces for Five Days.							
Sheep C, - - -	860	126	42	226	207	221	601
Sheep D, - - -	884	114	49	225	210	248	598
Amounts Digested.							
Sheep C, - - -	—	336	70	1,202	283	87	1,891
Sheep D, - - -	—	348	63	1,203	280	60	1,894
Percentage Digested.		%	%	%	%	%	%
Sheep C, - - -	—	72.7	62.5	84.2	57.8	28.2	75.9
Sheep D, - - -	—	75.3	56.3	84.2	57.1	19.5	76.0
Average, - -	—	**74.0**	**59.4**	**84.2**	**57.5**	**23.9**	**76.0**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C, - -	11,928	3,144	8,784	294	8,490	71.2
Sheep D, - -	11,928	3,174	8,754	303	8,451	70.9
Average, - -	—	—	—	—	—	**71.1**

DIGESTION EXPERIMENT No. 24.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water.	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Sweet corn fodder*–								
1496	Sample 1, - -	82.0	1.8	.5	11.0	3.7	1.0	17.0	.790
1532	Sample 2, - -	80.3	1.8	.6	12.5	3.6	1.2	18.5	.863
	Average, -	**81.1**	**1.8**	**.6**	**11.7**	**3.7**	**1.1**	**17.8**	**.827**
	Feces.								
1526	Sheep C, - -	5.3	12.4	2.7	45.0	22.6	12.0	82.7	4.288
1527	Sheep D, - -	5.1	12.3	2.3	45.8	25.4	9.1	85.8	4.405

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C, - - -	14,000	252	84	1,638	518	154	2,492
Sheep D, - - -	14,000	252	84	1,638	518	154	2,492
Feces for Five Days.							
Sheep C, - - -	638	79	17	288	144	75	528
Sheep D, - - -	860	106	20	394	218	78	738
Amounts Digested.							
Sheep C, - - -	—	173	67	1,350	374	79	1,964
Sheep D, - - -	—	146	64	1,244	300	76	1,754
Percentage Digested.		%	%	%	%	%	%
Sheep C, - - -	—	68.7	79.8	82.4	72.2	51.3	78.8
Sheep D, - - -	—	57.9	76.2	75.9	57.9	49.4	70.4
Average, - -	—	**63.3**	**78.0**	**79.2**	**65.0**	**50.4**	**74.6**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C, - -	11,578	2,736	8,842	151	8,691	75.1
Sheep D, - -	11,578	3,788	7,790	127	7,663	66.2
Average, - -	—	—	—	—	—	**70.6**

DIGESTION EXPERIMENT No. 25.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Rowen grass*—								
1530	Sample 1, - -	63.3	5.6	2.1	17.1	9.0	2.9	33.8	1.670
1531	Sample 2, - -	71.1	4.9	1.8	12.6	7.2	2.4	26.5	1.333
	Average, -	**67.2**	**5.3**	**1.9**	**14.9**	**8.1**	**2.6**	**30.2**	**1.502**
	Feces.								
1528	Sheep B, - -	5.1	11.9	6.8	38.8	25.8	11.6	83.3	4.666
1529	Sheep F, - -	4.4	12.9	8.0	40.4	22.4	11.9	83.7	4.624

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep B, - - -	12,000	636	228	1,788	972	312	3,624
Sheep F, - - -	12,000	636	228	1,788	972	312	3,624
Feces for Five Days.							
Sheep B, - - -	1,508	179	103	585	389	175	1,256
Sheep F, - - -	1,406	181	112	569	315	167	1,177
Amounts Digested.							
Sheep B, - - -	—	457	125	1,203	583	137	2,368
Sheep F, - - -	—	455	116	1,219	657	145	2,447
Percentage Digested.		%	%	%	%	%	%
Sheep B, - - -	—	71.9	54.8	67.3	60.0	43.9	65.3
Sheep F, - - -	—	71.5	50.9	68.2	67.6	46.5	67.5
Average, - -	—	**71.7**	**52.0**	**67.8**	**63.8**	**45.2**	**66.4**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep B, - -	18,024	7,036	10,988	398	10,590	58.8
Sheep F, - -	18,024	6,501	11,523	396	11,127	61.7
Average, - -	—	—	—	—	—	**60.3**

DIGESTION EXPERIMENT No. 26.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Barley fodder*—								
1533	Sample 1, - -	81.7	3.2	.9	8.3	4.0	1.9	16.4	.810
1534	Sample 2, - -	77.5	3.7	.7	10.0	6.0	2.1	20.4	1.000
	Average, -	**79.6**	**3.5**	**.8**	**9.1**	**5.0**	**2.0**	**18.4**	**.905**
	Feces.								
1605	Sheep B, - -	7.8	13.0	4.8	38.4	23.1	12.9	79.3	4.331
1606	Sheep F, - -	7.6	12.9	4.5	37.4	24.6	13.0	79.4	4.304

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep B, - - -	14,000	490	112	1,274	700	280	2,576
Sheep F, - - -	14,000	490	112	1,274	700	280	2,576
Feces for Five Days.							
Sheep B, - - -	1,018	132	49	391	235	131	807
Sheep F, - - -	1,026	132	46	384	252	133	814
Amounts Digested.							
Sheep B, - - -	—	358	63	883	465	149	1,769
Sheep F, - - -	—	358	66	890	448	147	1,762
Percentage Digested.		%	%	%	%	%	%
Sheep B, - - -	—	73.1	56.3	69.3	66.4	53.2	68.7
Sheep F, - - -	—	73.1	58.9	69.9	64.0	52.5	68.4
Average, - -	—	**73.1**	**57.6**	**69.6**	**65.2**	**52.8**	**68.5**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep B, - -	12,670	4,409	8,261	311	7,950	62.8
Sheep F, - -	12,670	4,416	8,254	311	7,943	62.7
Average, - -	—	—	—	—	—	**62.7**

DIGESTION EXPERIMENT No. 27.

Composition of Feeding Stuffs and Feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuffs.	%	%	%	%	%	%	%	Cal.
	Canada pea fodder*								
1535	Sample 1, - -	87.7	3.3	.6	4.1	2.8	1.5	10.8	.585
1536	Sample 2, - -	85.3	4.1	.7	5.4	3.1	1.4	13.3	.669
	Average, -	**86.5**	**3.7**	**.6**	**4.8**	**3.0**	**1.4**	**12.1**	**.627**
	Feces.								
1607	Sheep C, - -	7.7	14.7	6.3	29.2	23.7	18.4	73.9	4.167
1608	Sheep D, - -	6.9	14.0	6.1	31.3	25.1	16.6	76.5	4.290

* Fed green.

† Per gram as determined in calorimeter.

Weights of Foods Eaten, and of Feces for Five Days, and Weights and Percentages of Nutrients Digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C, - - -	14,000	518	84	672	420	196	1,694
Sheep D, - - -	14,000	518	84	672	420	196	1,694
Feces for Five Days.							
Sheep C, - - -	665	98	42	193	158	122	491
Sheep D, - - -	628	88	38	196	158	104	480
Amounts Digested.							
Sheep C, - - -	—	420	42	479	262	74	1,203
Sheep D, - - -	—	430	46	476	262	92	1,214
Percentage Digested.		%	%	%	%	%	%
Sheep C, - - -	—	81.1	50.0	71.3	62.4	37.8	71.0
Sheep D, - - -	—	83.0	54.8	70.8	62.4	46.9	71.7
Average, - -	—	**82.0**	**52.4**	**71.0**	**62.4**	**42.3**	**71.3**

Fuel Value of Food for Five Days as Determined by the Bomb Calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Per cent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C, - -	8,778	2,771	6,007	365	5,642	64.3
Sheep D, - -	8,778	2,694	6,084	374	5,710	65.0
Average, - -	—	—	—	—	—	**64.6**

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